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Asosiasi Perikanan Pole and Line dan Handline Indonesia

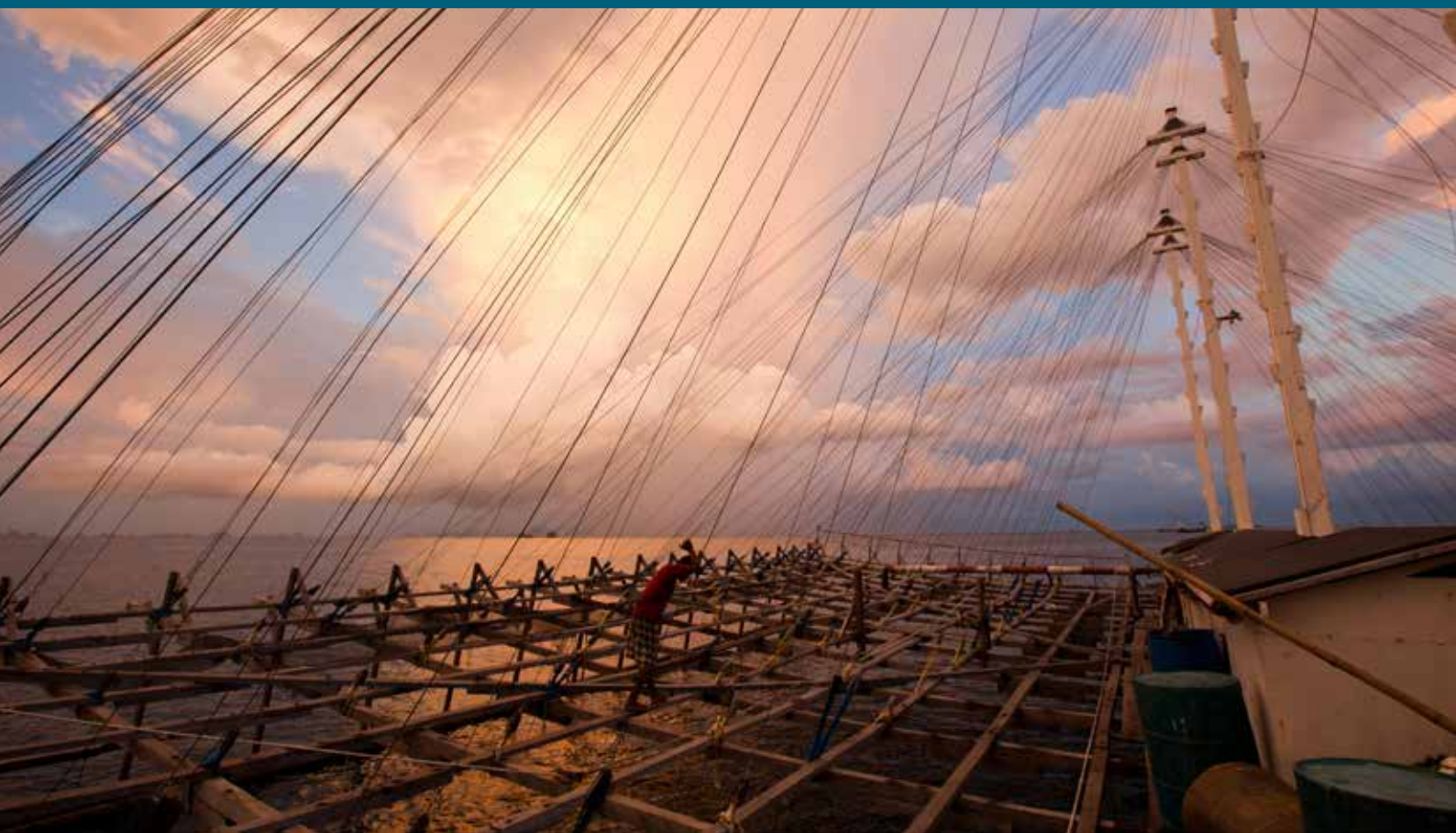


IPNLF
INTERNATIONAL POLE
& LINE FOUNDATION

IPNLF Technical Report No. 3

Improving the Management of Baitfisheries Associated with Pole-and-Line Tuna Fishing in Indonesia

by Robert Gillett



This report has been authored by Robert Gillet, in association with the International Pole and Line Foundation and Asosiasi Perikanan Pole-and-line dan Handline Indonesia.

This document should be cited as:

Gillet, R. (2014). Improving the Management of Baitfisheries Associated with Pole-and-Line Tuna Fishing in Indonesia. IPNLF Technical Report No. 3, International Pole and Line Foundation, London. 117 Pages.

Robert Gillett is a fisheries specialist based Suva, Fiji. He is a director of the fisheries consulting firm Gillett, Preston and Associates – which works mainly in the island countries of the Pacific and Indian Oceans. Gillett has carried out work on tuna baitfish in about 30 countries – including regional and global baitfish surveys. He is currently a member of the International Pole and Line Foundation’s Scientific and Technical Advisory Committee.



The International Pole and Line Foundation (IPNLF) is an international charity working to develop and demonstrate the value of pole-and-line caught tuna to thriving coastal communities. IPNLF’s ambition is to improve the wellbeing of coastal fisheries, and the people and seas connected with them, through environmentally and socially sustainable pole-and-line fishing.

UK Registered Charity 1145586



Asosiasi Perikanan Pole and Line dan Handline Indonesia (AP2HI) are an Indonesian task force dedicated to supporting the development of coastal tuna fishing activities in Indonesia, with members including fishers, exporters, processors and producers. With representation across the value chain for both pole-and-line and hand line, AP2HI play a lead role in encouraging efficiency within industry and to align with international market requirements. AP2HI promote fair, transparent, sustainable use of Indonesia’s resources and work to gain further support for their fishery. AP2HI represent a shared voice for all businesses involved in pole-and-line and hand line fisheries in Indonesia.

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Abbreviations Used in this Report

ACIAR	Australian Centre for International Agriculture Research
CPUE	Catch per Unit Effort
DKP	Departemen Kelautan dan Perikanan [Fisheries Offices at Provincial and District level]
EAFM	Ecosystem Approach to Fisheries Management
EEZ	Exclusive Economic Zone
ETP	Endangered, Threatened and Protected
FAO	Food and Agriculture Organization of the United Nations
FFA	Forum Fisheries Agency
FIP	Fishery Improvement Project
FMA	Fisheries Management Area
MPA	Marine Protected Area
MSC	Marine Stewardship Council
NMFS	US National Marine Fisheries Service
P/L	Pole-and-line
PSA	Productivity Sensitivity Analysis
SICA	Scale Intensity Consequence Analysis
SPC	Secretariat of the Pacific Community
TNC	The Nature Conservancy
WCPFC	Western and Central Pacific Fisheries Commission
WCPO	Western and Central Pacific Ocean
WWF	World Wide Fund for Nature

The survey	The International Pole & Line Foundation (IPNLF) and its Indonesian stakeholders are working on improving the management of Indonesian pole-and-line fisheries and the associated bait fisheries. As part of this process, a baitfish management specialist was engaged. The specialist was charged with several tasks, including articulating current management issues and difficulties in baitfishing in Indonesia, mitigating baitfish shortages for pole-and-line tuna fishing, examining the issue of using fishery management plans, and outlining the future steps for improving the management of the country's baitfisheries.
This report	The substantive parts of this report are laid out as: <ul style="list-style-type: none"> • Summary information on baitfishing and its management at the three locations visited (with the details in appendices). • A discussion of fisheries management plans, in general and then specifically in Indonesia. • An examination of Indonesia baitfishery management issues and difficulties. • A proposed strategy for producing a baitfishery management plan: basic concepts, the management framework (objectives, components of the management scheme, the management unit, form of the management plan), and the way ahead.
Main observations at Larantuka	<ul style="list-style-type: none"> • The “low hanging fruit” for improving the management of baitfishing in the area appears to be improving baitfish handling. • The WWF program has made a good start on the monitoring of baitfish but could benefit from technical oversight and knowledge of the results of previous baitfish research. • The District government has little heritage of fisheries management and little information on resource condition. • Management improvements promoted by IPNLF would need to be sensitive to the limited capabilities/interest at the district government level and be compatible with the on-going NGO work.
Main observations at Sorong	<ul style="list-style-type: none"> • The baitfish handling appears to be somewhat gentler at Sorong than at Larantuka – but still brutal compared to that of the South Pacific. • Individuals associated with bagan fishing have a low opinion of the benefits of MPAs for baitfish resource sustainability. • The management of marine activities in the Raja Ampat area appears largely based on MPAs, whose establishment is encouraged by NGOs. • The “black anchovy” is presumably <i>Encrasicholina punctifer</i> (75% of the baitfish catch in Raja Ampat). If so, the fish is oceanic in nature is not likely to be subjected to resource over-exploitation from bagan fishing in the area.
Main observations at Bitung	<ul style="list-style-type: none"> • The Bitung-based pole-and-line fleet has not expanded remarkably in the last 20 years. The reported expansion of baitfishing by bagans could be due to (a) the expansion of demand for baitfish for food, (b) the reported contraction of beach seining, or (c) lower CPUE of bagan fishing. • With the December to March period being the bad season for baitfishing and September to December being the good season for pole-and-line fishing, it is easy to see why seasonal bait shortages occur. • The district government has little heritage of fisheries management and little information on resource condition. • In common with Larantuka and Sorong, the baitfish handling techniques are quite rough and the bait to tuna ratio is quite poor. Much could be done to improve this situation.

NGOs	A common feature for each of the locations visited in the survey is the low level of fisheries management skills/experience by the district government agencies dealing with fisheries. In this situation, the presence of marine-oriented NGOs is a major advantage when contemplating improvements to fisheries management. Both Lantoka and Sorong (Raja Ampat) have substantial programmes sponsored by major international NGOs, but around Bitung there is apparently no marine NGO presence.
WWF at Lantoka	From discussions with the enumerators and supervising WWF staff, it appears that their work in Lantoka is well-organised and timely. The enumerators have considerable pride in their work. Although the baitfishing and sampling operations were not observed during the present survey (poor weather resulted in no baiting), several suggestions are made to improve the baitfish monitoring.
TNC at Raja Ampat	The positive results of the work NGO groups active in the marine areas of Raja Ampat is indisputable. It appears, however, that the situation could be improved if those NGOs are made aware of higher-level conservation benefits related to bagan fishing: the national value of promoting environmentally-friendly pole-and-line tuna fishing in the world's largest tuna fishing nation.
A challenging aspect of improving management	A major problem of baitfishery management in Indonesia is the practicality of improving the management of fisheries supplying bait that are surrounded by fisheries that are poorly managed. The recommendations given in this report are based largely on the general strategy of working initially in one or two locations where there is the greatest chance of success and then expanding to other locations.
Baitfish shortages	In examining the issue of baitfish shortages, a number of observations can be made: <ul style="list-style-type: none"> • Many reports on baitfisheries in Indonesia comment on baitfish shortages. • The most comprehensive studies focussing on baitfish shortages point to natural variation in abundance and/or increased use of bait as food – rather than simply over-exploitation by baitfishing. • The solutions offered for mitigating baitfish shortages for the pole-and-line fleet include using alternative baitfishing techniques (e.g. boke ami gear), restrictions on the non-bait use of baitfish, culturing baitfish, and reduction of wastage in bait handling/storage/utilization. Each of these is considered in this report.
Tuna-baitfish ratios	The tuna-baitfish ratios at the height of the Pacific Islands pole-and-line fisheries were around 32:1. The ratios at the three locations visited were reported to be much less.
Bait wastage	Bait wastage can be thought of as having three components: <ul style="list-style-type: none"> • Poor baitfish handling: for many of the bait species commonly used in Indonesia (e.g. the anchovies <i>Encrasicholina devisi</i>, <i>E. heteroloba</i>), any contact that the fish have with a hard surface (e.g. side of bucket, net, other fish) during the transfer operation will tend to result in scale loss, contributing to mortality. • The manner in which baitfish are stored aboard a pole-and-line vessel also has a large impact on mortality. This includes the kind of circulation in the bait tanks, lighting of the tanks, and density of baitfish in the tanks. • The third form of bait wastage is more subtle: using more bait than necessary to chum a tuna school. This involves the fishing skill of the pole-and-line vessel captain and the crew doing the chumming. <p>Much can be done to decrease this wastage, especially for bait handling. Improvements would tend to mitigate baitfish shortages.</p>

Milkfish culture	<ul style="list-style-type: none"> • Several of the unknowns of baitfish culture in Indonesia can be clarified by the experience from the central and western Pacific. In terms of the type of fish to be selected for culture, milkfish is very likely to be the most appropriate species. When treated and used properly, milkfish has very good survival in bait tanks and a very favorable tuna to bait ratio. • Baitfish culture has not proven to be viable in the central and western Pacific, but some of the conditions are more favorable in Indonesia: a tradition of pole-and-line fishers purchasing baitfish and heritage of successful aquaculture for other species/purposes. • Several Indonesian companies now have experience in the culture of milkfish for pole-and-line bait. They are likely to have considerable insight into the feasibility of baitfish culture, and in a position to decide whether to proceed (and shoulder the costs) of milkfish culture. It would seem that if the economics of baitfish culture are dubious, the companies would be enthusiastic about the government taking on milkfish culture as a service to the industry.
Conclusions on mitigating baitfish shortages	The report discusses several ways that baitfish shortages can be mitigated. Each of these may have a positive impact, but the pole-and-line fishing companies should not discount the value of the three ways to decrease baitfish wastage.
Controls on fishers	<ul style="list-style-type: none"> • It is essential that a fisheries management plan have controls available for use when certain limits are exceeded – hence the importance of identifying appropriate controls for Indonesia's baitfishery at the beginning of the planning process. • It appears that baitfish management in Indonesia is in danger of being reliant on non-functional controls. To overcome this fundamental problem, it is strongly recommended that only those controls that have had some degree of success in Indonesia be proposed for the new baitfish management scheme. • A marine protected area, although far from an ideal control, appears to be one of the few controls that may work in baitfishery management.
Bait vs. food	The partitioning of the bagan catch between bait and food is a large issue that is likely to grow in significance. In the pole-and-line industry's quest for sufficient baitfish, any initiatives that promote the concept that baitfish should receive preference over food should be carefully considered, as there is the possibility that it may tarnish some of the positive social credentials of pole-and-line fishing.
Management authority: Districts vs. central government	Currently, the situation is not as simple as the districts having autonomy in fisheries affairs within four miles (i.e. the bagan fisheries being managed by the districts). During the present survey, discussions with fisheries officials at the district, province, and national level lead to the conclusion that the current situation for fisheries management inside four miles is a complex sharing of authority between levels of government that has evolved over the last decade, and involves many considerations including those relating to financing and institutional capacity. The reality is that the central government agencies have the skills/experience/money for management fisheries activities - and because of that, much management within four miles is carried out by the central government simply because they are able to do it.
Historical information	From the comments on required baitfish research made during the present survey by many individuals and those made in various documents, there appears to be a significant amount of "reinventing the wheel". That is, an expressed desire to carry out research on topics that have already been well-studied. In the heyday of pole-and-line fishing in the world, much research was done on topics such as interactions with food fisheries, basic biological characteristics of particular species, baitfish mortality, and culturing bait. This fact does not eliminate the need for additional research, but it would be quite inefficient to carry out new research in ignorance of past results. The need here appears to be a compilation of previous baitfish research findings, including overall lessons learned.

MSC and baitfisheries	There is a large range of views on the MSC requirement for baitfisheries, and therefore some clarification of the situation is required. Accordingly, the issue was discussed at the IPNLF advisory meeting in February 2014. The report of that meeting gives high priority to IPNLF trustees obtaining definitive clarification from MSC (staff, technical advisors and board) of the requirements for a baitfishery associated with a fishery undergoing certification.
A strategy for producing a management plan	It is proposed that the production of a baitfishery management plan be based on several general concepts: <ul style="list-style-type: none"> • The scheme will be based initially on two sites: Larantuka and the Raja Ampat area of Sorong. • The general strategy would be to get management going at two locations where it is relatively easy to work and then, after it is up/running, expand the management to other areas. • A management plan for a baitfishery is not absolutely necessary, but in a developing country like Indonesia, a plan would be very helpful in facilitating management improvements. • Management improvements promoted by IPNLF would need to be sensitive to the limited capabilities/interest at the district government level and compatible with the on-going NGO work. • Considering the huge task of improving baitfishery management in Indonesia, work in cooperation with established NGOs is highly desirable, if not essential. • Only those controls on fishers that have had some degree of success in Indonesia should be relied upon in the baitfish management scheme. • Local baitfishery management plans prepared in the near future can be incorporated into FMA-type plans that may be prepared in the longer term. • Wherever possible and appropriate, use should be made of previous baitfish research. • Simplicity is the key: the baitfishery management plan should be a short document that people and agencies will become familiar with and will keep and use.
The main components of the management scheme	It is proposed that the management scheme be minimalist and consist of just three components. <ul style="list-style-type: none"> • <u>Obtaining information on status of the baitfish resources</u>: first by using the available information, then by extrapolating from studies on similar areas and same species, then (if justified) new research. • <u>Establishment of a monitoring system</u> (or latching on to an existing system) that is oriented to learning of changes important to the management objectives (i.e. changes in baitfish CPUE, changes in baitfish mortality). • <u>Establish a system of controls</u> (or latching on to an existing system) that would kick in when the monitoring detects problem. The MPA system is suggested, but there may be others that are effective in Indonesia.
The way ahead	From the perspective of the baitfishery management specialist, a number of steps are required to progress from the present situation to having a functional baitfishery management plan. 17 steps are proposed. IPNLF staff and other stakeholders will probably want to modify the list. The required steps are likely to change depending on the discussions with the NGOs, companies, and government officials at various levels. Some thoughts on task allocation are given.
Baitfish management workshops	Baitfishery management workshops should be held in Larantuka and Raja Ampat. It is proposed that the main objectives of the workshops should be to: <ul style="list-style-type: none"> • Obtain a consensus by the major stakeholders of what the objectives of the management of the baitfisheries should be – and a prioritization of those objectives. • Settle on the most appropriate control mechanisms: MPAs or otherwise. • Promote stakeholder buy-in of the management process through their input at the workshops. • Gauge the interest of the various participants of participating in the process, and partition responsibilities amongst those interested.
Major recommendation	The major recommendation arising from this survey is that IPNLF study closely the section “A Strategy for Producing a Management Plan” and endorse or modify the ideas put forward, including the general concepts, the management framework (objectives, components of the management scheme, the management unit, form of the management plan), and the future steps to be taken.

1. Introduction



1.1 Background to the study

The International Pole & Line Foundation (IPNLF) and its Indonesian stakeholders are working on improving the management of Indonesian pole-and-line fisheries and the associated bait fisheries. As part of this process, a baitfish management specialist was engaged.

The specialist was charged with several tasks, including articulating current management issues and difficulties in baitfishing in Indonesia, mitigating baitfish shortages for pole-and-line tuna fishing, examining the issue of using fishery management plans, and outlining the future steps for improving the management of the country's baitfisheries.

This report is intended to provide some technical information on baitfisheries and their management, as well as to suggest a process for improving the management of baitfisheries in Indonesia.

1.2 Methodology

The baitfish specialist arrived in Indonesia on January 12, 2014 and remained in the country for 21 days. During that period he visited Jakarta, Kupang, Larantuka, Sorong, and Bitung. The travel was undertaken with IPNF's Indonesia representative.

A total of 70 people were consulted on the baitfisheries and their management. In addition, information was obtained from 36 references. Those people and documents are given in this report in Appendix 1 and Section 11.0, respectively.

Information was obtained primarily through interviews, with opinions on important issues being obtained from the perspective of several types of stakeholders. The approach taken was based on the concept that a good knowledge of a fishery is an essential pre-requisite for providing fisheries management advice. Accordingly, considerable effort was focused on documenting the baitfishing activities at the three locations visited, for both the current work and other efforts that may follow.

To some degree, this survey relied on the findings of the author's global study of baitfish management (Gillett 2012) and his work on baitfish management in the

Maldives (Gillett 2013). The global study culminated with the “Baitfish Management Think-Tank” in August 2012 that brought together baitfish specialists from western Pacific, eastern Pacific, eastern Atlantic, and the Indian Ocean. The opinions of the meeting on several challenging issues in baitfish management have considerable relevance to Indonesia – and are referred to in several places in this report.

A major limitation of the survey of the three locations was the inability to observe actual baiting operations. This was because of poor weather, arriving during the low-fishing season, extensive time/logistical requirements for a bagan visit, or all three. This was partially compensated for by the baitfish consultant’s past experience in many places in the world. Nevertheless, more information could have been obtained on baitfish handling and baitfish species identification had a bagan visit occurred.



Figure 1. Mobile Bagans

Some clarification of terminology used in this report is required:

- In this report the terms “bait”, “baitfish”, and “baitfishery” concern live baitfish used in pole-and-line tuna fishing, which is sometimes abbreviated to P/L in tables.

- Although the use of the term “tuna” in Indonesia often is confined to the larger species (e.g. yellowfin and bigeye), in this report “tuna” also includes skipjack.
- It should be noted that in Indonesia there is no common understanding of the term “fisheries management”. It therefore may be useful to establish that for the purpose of this report, “management” is defined to be “interventions in support of established objectives”.
- A “bagan” is a stationary platform or mobile fishing vessel from which a lift net is operated. Figure 1 shows some mobile bagans.

The study benefited significantly from extensive discussions with Antony Lewis and David Itano, individuals with a great amount of knowledge of baitfisheries and experience with baitfishing in Indonesia. Andrew Bassford, Aminudin Salka, and Emily Howgate of IPNLF were a pleasure to work with and are acknowledged for their excellent administrative and travel arrangements.

1.3 Layout of this Report

The substantive parts of this report are laid out as:

- Summary information on baitfishing and its management at the three locations visited (with the details in appendices).
- A discussion of fisheries management plans, in general and then specifically in Indonesia.
- An examination of Indonesia baitfishery management issues and difficulties.
- A proposed strategy for producing a baitfishery management plan: basic concepts, the management framework (objectives, components of the management scheme, the management unit, form of the management plan), and the way ahead.

2. Information on the Bait Fish Fisheries of the Three Areas Visited



Visits of three to four days were made to administrative centers close to three important baitfishing locations. These were Larantuka, Sorong, and Bitung. At those locations attempts were made to collect as much baitfishery information as possible in 17 categories:

- Information on live-bait pole-and-line tuna fishing in the area
- Baitfish requirements
- The scope of the baitfishery(ies) in the area; the unit of coverage
- The various baitfishing operations: types of operations, size of operations and techniques
- The major baitfish species
- Cost of baitfish
- Baitfish handling and wastage
- Who controls the baitfishing operations?
- Numbers of units; annual production
- The recent trends in the baitfishery, including trends in catches
- What are the major concerns that management should address?
- Current management of the baitfishery
- The main institutional and procedural difficulties in the management of the baitfishery
- Aquaculture considerations
- MSC considerations
- Observations and recommendations
- Main informants

The details collected in those 17 categories at the three locations visited are given in Appendices 2, 3, and 4.

2.1 Summary Information

Some of the above information is especially important for the improvement of the management of the baitfisheries. This is summarized and compared in Table 1 .

2.2 Some Observations on the Three Baitfishing Locations

At the conclusion of the visits to each of the baitfishing locations a number of observations related to management were made. These are summarised in Table 1 (pages 22-24)

Larantuka:

- The “low hanging fruit” for improving the management of baitfishing in the area appears to be improving baitfish handling.
- WWF program has made a good start on the monitoring of baitfish but could benefit from technical oversight and a knowledge of the results of previous baitfish research.
- It may be hard to convince the government of the need to monitor and to make other improvements related to the management of a relatively unimportant fishery.
- The District government (which has the legal management authority) has little heritage of fisheries management and little information on resource condition.
- Management improvements promoted by IPNLF would need to be sensitive to the limited capabilities/interest at the district level and compatible with the on-going NGO work.

Sorong:

- The baitfish handling appears to be somewhat gentler here than in Larantuka – but still brutal compared to that of the South Pacific. At both locations the pricing scheme (money paid per bucket of bait) may lead to the pole-and-line crew to pack as much bait as possible into the buckets – which leads to increased baitfish mortality.
- Individuals associated with bagan fishing have a low opinion of the benefits of MPAs for baitfish resource sustainability.
- The management of marine activities in the Raja Ampat area appears largely based on MPAs, whose establishment is encouraged by NGOs. Interviews with staff of one NGO suggest they are not very focused on bagan fishing or the targeted resources. It appears that those NGOs could easily be made aware of how bagan fishing promotes higher level conservation goals – such as environmentally-friendly tuna fishing in the world’s largest tuna fishing nation.
- The “black anchovy” is presumably *Encrasicholina punctifer* (75% of the baitfish catch in Raja Ampat). If so, the fish is oceanic in nature and is not likely to be subjected to resource over-exploitation from bagan fishing in the area.

Bitung:

- The Bitung-based pole-and-line fleet has not expanded remarkably in the last 20 years. The reported expansion of baitfishing by bagans could be due to (a) the expansion of demand for those baitfish for food, (b) the reported contraction of beach seining, or (c) lower CPUE of bagan fishing.
- With the December to March period being the bad season for baitfishing and September to December being the good season for pole-and-line fishing, it is easy to see why seasonal bait shortages occur.
- The District government (which has the legal management authority) has little heritage of fisheries management and little information on resource condition.
- In common with Larantuka and Sorong, the baitfish handling techniques are quite rough and the bait to tuna ratio quite poor. Much could be done to improve this situation.

2.3 Some General Comments

Some comments can be made for the three sites that have implications for the management of baitfisheries:

- Attempts to obtain annual pole-and-line tuna production from the companies based at the three locations produced dubious information, presumably because of commercial secrecy. The best indication of the magnitude of local tuna production appears to be the number and size of the local operational pole-and-line vessels.
- To some degree, the lack of knowledge of the amount of bait carried in a standard bucket made it more difficult during the present survey to understand many aspects of the baitfisheries, such as proper baitfish handling, relative efficiency of bait use, and the economics of baitfishing.
- Like several studies in the past (e.g. Itano, 1993; SPC, 2008), the present survey points to baitfish wastage due to poor handling at all three locations. Reduction of unnecessarily high baitfish mortality would please fishers and have a favorable impact on the resource.
- Another common feature for each of the locations visited in the survey is the low level of fisheries management skills/experience by the district government agencies dealing with fisheries. In this situation, the presence of marine-oriented NGOs is a major advantage when contemplating improvements to fisheries management. Both Larantuka and Sorong (Raja Ampat) have substantial programmes sponsored by major international NGOs, while around Bitung there is apparently no marine NGO presence. The issue of NGOs is further explored in the next section.

Table 1: Comparison of Baitfishing Features at the Three Sites Visited

Feature	Larantuka	Sorong	Bitung
Number of P/L vessels	80 to 100 pole-and-line boats are based in Larantuka, but only about 60% are operational	31 active pole-and-line vessel are associated with companies that operate out of Sorong	About 50 vessels (40 to 80 GT), with estimates of between 10 and 40% of those vessel being non-operational.
Number of bagans	39 bagans operate in 5 locations around Larantuka	In the Raja Ampat and Fakfak baiting areas there are about 39 bagans that provide bait to pole-and-line boats.	About 100 vessels (not including associate light boats) plus about another beach seines
Baitfish handling	Three bagan fishing captains indicate baitfish mortality (which presumably spans the period from pulling the net to pole-and-line transfer) as being about 20 to 30%. The WWF enumerators indicate that bait is dry-scooped in the transfer process (i.e. very rough handling)	A video of baitfishing shows that for the transfer bagan > vessel, bait is semi dry-scooped (i.e. as the scoop net is raised out of the bagan net, some baitfish remain underwater, some are raised out of the water) into a bucket half full of water and then passed to the bait well (i.e. fairly rough handling)	The baitfish transfer (bagan>pole-and-line vessel) as described by pole-and-line vessel operators and bagan owners consists of crowding the bait in the bagan net and using the transfer bucket as a scoop, without the use of a scoop net (i.e. fairly rough handling).
Main trends in the baitfishery	<ul style="list-style-type: none"> • Three bagan owners say the number of bagans in the general Larantuka area have definitely increased in the last decade; from about 20 ten years ago to 39 today. • A general decline in CPUE is recognized by bagan fishing captains, pole-and-line fishing companies, and the one bagan owner interviewed. • There is also increasing demand for baitfish as food, plus the additional demand created by a new fish meal plant in the district. 	<ul style="list-style-type: none"> • PT Citraraja, which obtains bait in Raja Ampat, states no drop in CPUE in the last decade – with the only noticeable trends being the increasing baitfishing area being dedicated to marine protected areas (which tends to reduce total catch), and (b) the increasing amount of baitfish used as food. • Using fisher interview data collected in the Raja Ampat archipelago, Ainsworth et al. (2008) suggest a decline in the relative abundance of anchovy during the period 1980 to present. [methodology requires scrutiny] 	<ul style="list-style-type: none"> • The number of P/L has increased only slightly over the last 20 years. • The number of bagans also increased over the last decade (catering to the baitfish needs of what they feel is an expanding pole-and-line fleet), while the number of beach seines has declined (low profitability). • Fleet managers and vessel operators feel that bagan CPUE has fallen a bit in the last decade. This is mainly attributed to catches of the same fish by other gear types (e.g. shore-based fishing, small purse seining) and the effects of near-shore FADs.

(continued on pg 23)

Table 1: Comparison of Baitfishing Features at the Three Sites Visited (continued)

Feature	Larantuka	Sorong	Bitung
What are the major concerns management may be able to address?	<ul style="list-style-type: none"> • A drop in baitfish CPUE since 2000. • Competition between P/L vessels for limited bait supplies. • Negative interactions with lampara and purse seine fishers: competing for the resource and conflict on fishing grounds. • Although not mentioned in interviews, there is very high mortality of baitfish; wastage of bait could be addressed by management. 	<ul style="list-style-type: none"> • According to the fishing operations manager of PT Citraraja, there has been no decline in baitfish CPUE in the last decade and no bagan-related conflicts – but some competition • The major baitfishing problems are associated with creeping fee demands and creeping MPA areas. 	<ul style="list-style-type: none"> • Fishing companies and fleet managers indicate conflict between bagan fishers for baitfishing area, rivalry between pole-and-line boats for the limited baitfish supplies at certain times of the year, and competition between gear types at the resource level. They also feel that something should be done about the effects of near-shore FADs on the behavior of layang. • Bagan owners are quite fixated on improving mechanisms for distributing government grants for bagan gear
Current management of the baitfishery	<ul style="list-style-type: none"> • When questioned on current management, most stakeholders indicated that no management or rules are applied to the fishery – but on probing, they recognize that licensing could be considered a form of management. Of the three bagan captains interviewed, none were operating a licensed vessel, saying that their licenses were “being processed”. • There is also the informal use of “local wisdom” such as not disturbing other bagans by fishing too close, prohibition on fishing on certain days and in certain areas (mainly due to religious reasons) 	<ul style="list-style-type: none"> • The current management of the baitfishery appears to be limited to the requirement for a license and the prohibition on fishing in MPAs. Less formally, there is the understanding that fees must be paid to communities adjacent to baiting grounds. • Subsidies could be considered a form of management intervention. According to the fishing operations manager of PT Citraraja, “working capital” is provided by DKP to some bagan operators. 	<ul style="list-style-type: none"> • Pole-and-line vessel operators indicate (a) an informal rule among bagan operators that a bagan should not encroach into another bagan’s fishing area, (b) bagans should fish close to shore so as not to disturb the navigation of other vessels, (c) no fishing/anchoring in the Bunaken National Park (heavy penalties), and (d) a common understanding not to fish near resorts. • Although there is some confusion over license requirements, baitfishers say that they are definitely licensed, and cite fees paid. They agree that Bunaken is a no-take zone. They add that an informal rule stipulates that there should be at least 30 metres between bagans.

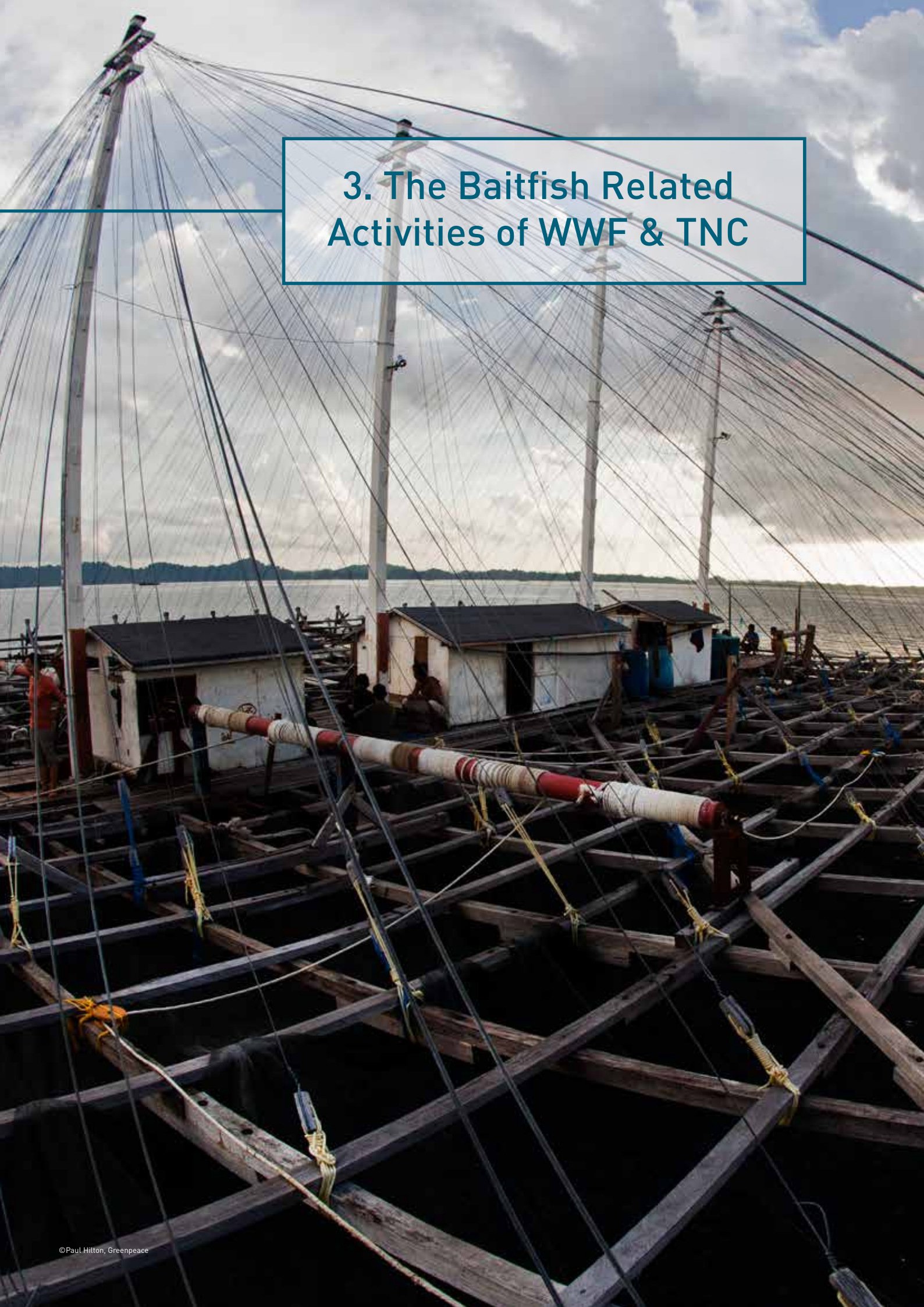
(continued on pg 24)

Table 1: Comparison of Baitfishing Features at the Three Sites Visited (continued)

Feature	Larantuka	Sorong	Bitung
The main institutional & procedural difficulties in managing the baitfishery	<ul style="list-style-type: none"> • There is little heritage of successful fisheries management in the area. The district has the authority for management of the fisheries in the area where bagans operate, but at that level of government there is little experience and skills in management. • Improving the management of the bagan fishery would be a very large task in the district, but bagan fishing is relatively unimportant in the area. 	<ul style="list-style-type: none"> • Fishing companies, pole-and-line operators, and bagan captains, feel that government agencies, (including the DKP) have had little interaction with baitfishing • Discussions with the staff of one NGO involved with MPAs suggests they are not very focused on bagan fishing or resources targeted by bagans. • In the Raja Ampat area, tourism-oriented objectives appear much more important than objectives associated with bait fishing. 	<ul style="list-style-type: none"> • A fleet manager indicated that the DKP is sometimes useful, to the extent that they sometimes provide subsidized gear. • DKP Bitung City was asked what would be the management response if a major drop in baitfishing CPUE should occur. They indicated that there would be a limitation of fishing gear or of fishing season. When asked how this would occur, they indicated “by the central government”. When asked about the district’s management authority inside four nautical miles, the response was unclear.

(source: Appendices 2-4)

3. The Baitfish Related Activities of WWF & TNC



3.1 WWF in Larantuka

In mid-2013 WWF established a programme of enumerators for bagan fishing, pole-and-line fishing, and demersal fishing. According to WWF staff, this work is generally in support of obtaining MSC certification for those fisheries. WWF works with both companies and the government. The baitfish sampling collects information on catch composition, total catch, and the number of active fishing units. This information will be analysed and provided to district fishery officials – who will presumably act on the information/advice. It is anticipated that, on the basis of the WWF-generated information, a head of district decree will be adopted later in 2014, which is likely to feature MPAs as management tool.

From talking to the enumerators and supervising WWF staff, it appears that their work in Larantuka is well-organised and timely. The enumerators have considerable pride in their work. Although the baitfishing and sampling operations was not observed during the present survey (poor weather resulted in no baiting), some suggestions can be made purely on the basis of discussions with staff and enumerators. WWF should:

- Determine the amount of bait in several randomly selected buckets during the bait loading process.
- Take a video of the bait loading operation, from bagan net to pole-and-line vessel bait well. This would help determine the extent of baitfish handling problems.
- Make absolutely sure of the baitfish taxonomy. In baitfisheries in other countries incorrect baitfish identification has negated much of the value of years of sampling.
- Conduct an external review of the baitfishery sampling strategy, information collection, and data analysis.
- Collect information on baitfish mortality on the bagan and on the pole-and-line vessel.
- Become familiar with the links between baitfish management objectives, required monitoring of baitfisheries, and appropriate management action. Obtain knowledge of the results of previous baitfish research.

3.2 The Nature Conservancy in Raja Ampat

Several MPAs have been established in the Raja Ampat area off Sorong with the support of NGOs. The Nature Conservancy (TNC) has supported six such zones around Raja Ampat. That same region is the baiting ground area for about 30 bagans that support the tuna fishing of 25 pole-and-line vessels. The bagan operators and fishing operators claim that, although the MPAs now exclude baitfishing in half of their former baitfishing areas, the baitfish abundance outside the MPA has not noticeably increased. On the other hand, TNC staff feel that the MPAs have halted the decline in baitfish abundance – a trend that was determined by consultation with communities adjacent to the baitfishing grounds. Those communities feel that they derive little benefit from bagan fishing. Government fisheries officials in Sorong feel that, although MPAs have had a positive effect on tourism and the environment, they have decreased the total baitfish catch in the Raja Ampat area. The bagan operators and fishing operators state that they were never consulted about the establishment of the MPAs – something that has a major impact on their livelihoods. TNC indicates that stakeholder consultation is an important part of the MPA establishment process, but as bagan operators are considered “outsiders”, they were not consulted. The positive results of the work of NGO groups active in the marine areas of Raja Ampat is indisputable. On further reflection, it appears that the situation could be improved if those NGOs are made aware of higher-level conservation benefits related to bagan fishing: the national value of promoting environmentally-friendly pole-and-line tuna fishing in the world’s largest tuna fishing nation.

3.3 A Major Advantage

One of the major uncertainties about IPNLF’s work on improving the management of baitfisheries in Indonesia concerns the incentives for district governments to become involved in baitfish management – bearing in mind that at that level of government there is not much interest/experience in fisheries management. It has become apparent during the present survey, that those areas where marine-oriented NGOs have carried out much work, they have engineered considerable interest in fisheries management by district governments. Quite simply, it is a major advantage to IPNLF if that situation can be taken advantage of (i.e. “piggybacking” on the foundations laid by the NGOs).

¹ It is acknowledged that the Raja Ampat area is not in the same district as Sorong, but the head of the DKP Sorong appears quite knowledgeable on baitfishing issues in Raja Ampat.

4. Management Plans



4.1 General

There is general recognition that fishery management plans have considerable value. This sentiment is embodied in FAO's Code of Conduct for Responsible Fisheries: Long-term management objectives should be translated into management actions, formulated as a fishery management plan or other management framework.

The use of fishery management plans has been promoted by FAO and many other entities sponsoring fisheries management work, including the World Bank, Asian Development Bank, European Union, USAID, and the UK Government's Department for International Development.

In 2012 a global study of baitfishery management was carried out (Gillett 2012). Several of the findings of that study are applicable to formulating and implementing baitfishery management plans in Indonesia, and are incorporated into the text below.

It is important to point out that many different types of documents can be called a "fishery management plan". These range from a government policy framework for management, to a recipe for establishing a catch limit, to a listing of enforceable rules. There is also a type of plan that gives fishery information, stock assessment results, government policy, management objectives, interventions to meet those objectives, and arrangements for enforcement and plan monitoring/modification. For lack of a better term, this latter type will be referred to in this report as an "FAO-type management plan" – and (unless otherwise noted) will be the type of fisheries plan promoted in this report.

There has been considerable enthusiasm in recent years for the use of plans in the management of baitfisheries:

- **International Seafood Sustainability Foundation:** "A sustainable pole & line fishery must have a management plan in place to protect important stocks of baitfish. This is essential, not optional."
- **Greenpeace:** "As the long-term success of the pole-and-line operations depend on the bait, it is of utmost importance that the conditions are set right for the operations and adequate management plans are in place".

- **International Pole & Line Foundation:** “IPNLF would, as a priority, develop best practise guidelines for baitfish management plans.”
- **MSC Assessment Report** for the pole-and-line skipjack fishery in the Maldives: the client action plan specifies “a finalized Baitfish Management Plan will be in place by the second annual audit.”

A comparative study of fishery management plans in another type of fishery in the Western Pacific (tuna) shows that the most challenging difficulty with introducing management plans is the failure to implement or adhere to plans after some form of formal adoption. One approach that appears to have some success (and which is promoted in the present survey) is to make the plans easier to implement and include multiple mechanisms to encourage adherence.

The simplicity of a fisheries management plan is important in developing countries. Box 1 (from the Maldives baitfishery management plan) comments on this minimalist approach.

Box 1: Simplicity of the Maldives Baitfishery Management Plan

Although numerous agencies promote the use of fishery management plans, the introduction of such plans in developing countries is often not successful. Where there have been successes, those plans usually feature simplicity. This plan has therefore been formulated to be as non-complex as possible, and downplays some features which add complications that could overpower the modest fisheries management capabilities of the Maldives. The goal is to have the plan be a short document that people/agencies will become familiar with and will keep and use.

Following from the simplicity sentiment, this plan is not meant to be a treatise on the baitfishery in Maldives, which is probably the best documented baitfishery in the world. Background information is kept to a minimum (mostly confined to an indication of the information that exists) with the idea that this interesting but peripheral information distracts from the core of fisheries management: objectives, controls, arrangements for applying controls, and monitoring.

Source: Gillett, Jauhareem and Adam (2013)

4.2 Fisheries Management Plans in Indonesia

Although there are some well-managed baitfisheries in the world without a fishery management plan (e.g. Japan), it appears that management plans can be a convenient way to organize fisheries management, improve efficiency, assure that interventions are tied to objectives, guide less sophisticated managers, and promote transparency. They become even more useful in complex situations and where stakeholders are unfamiliar with fisheries management processes. In short, fishery management plans appear to be quite appropriate for a country like Indonesia. This sentiment was similar to a remark made by a fisheries management specialist at FAO: “countries where there is no strong heritage of fisheries management success need a management plan more than the Norways and Japans of the world” (G. Bianchi, per.com.).

Having stated the desirability of a functional baitfish management plan, it is important to point out that the process of introducing a management plan in Indonesia is not easy. As an example, the management plan for the Lemuru Fishery in the Bali Straights is cited by many fishery stakeholders as the most significant example of an Indonesian fishery management plan. The reality, however, is that the process formulating/implementing that plan started 14 years ago and, according to many stakeholders, has not yet been fully implemented.

Based on a survey of baitfishing stakeholder comments in 2012, Box 2 attempts to portray the constraints and advantages of fishery management plans in the country.

Although a fishery management plan can tremendously facilitate the process of management, it does not make the most difficult part disappear: the effective placing of controls on fishers. As this is critically important, the topic will be re-visited in Section 5.5 below. In short, it is of great importance to only promote plans predicated on controls on fishers that have been successfully applied in other fisheries in Indonesia.

The government of Indonesia is committed to fisheries plans based on the 11 fisheries management areas (FMAs) of Indonesia. It should be noted that these FMA-type plans are quite different from the FAO-type management plans cited above – and serve primarily to coordinate fisheries management arrangements between geographical areas and levels of government (and often for shared resources). Without discounting the need/value of FMA-type management plans, another type of management plan is

Box 2: Constraints and Advantages of Baitfishery Management Plans in Indonesia

The main constraints to formulating and implementing a fishery management plan:

- The management of the vast majority of baitfishing (and most other inshore fisheries) is located in areas largely under the jurisdiction of the districts – and there are about 60 districts where baitfishing occurs. Making those government entities aware of the need for, and benefits of, fishery management plans would be an enormous task, not to mention plan implementation. “Cannot imagine getting delegates from 60 districts together to discuss/agree on baitfish management.”
- As the district governments often behave like “stubborn old men”, outside pressure not likely to be productive.
- From a national perspective, there is little heritage in Indonesia of the use of fishery management plans and the attempts to introduce such plans have not yielded much success. In terms of priorities for making radical changes to fisheries management schemes, the baitfisheries are relatively unimportant on the national scale and therefore would not receive much priority.

The advantages of the management plan approach:

- Transparency, encouragement of stakeholder participation, clarification of nebulous processes.
- In a country with little management of any fishery resources, a management plan can be an effective tool for educating fisheries officials.
- Several agencies are currently promoting fishery management plans in Indonesia: WWF, IMACS

Source: Gillett (2012)

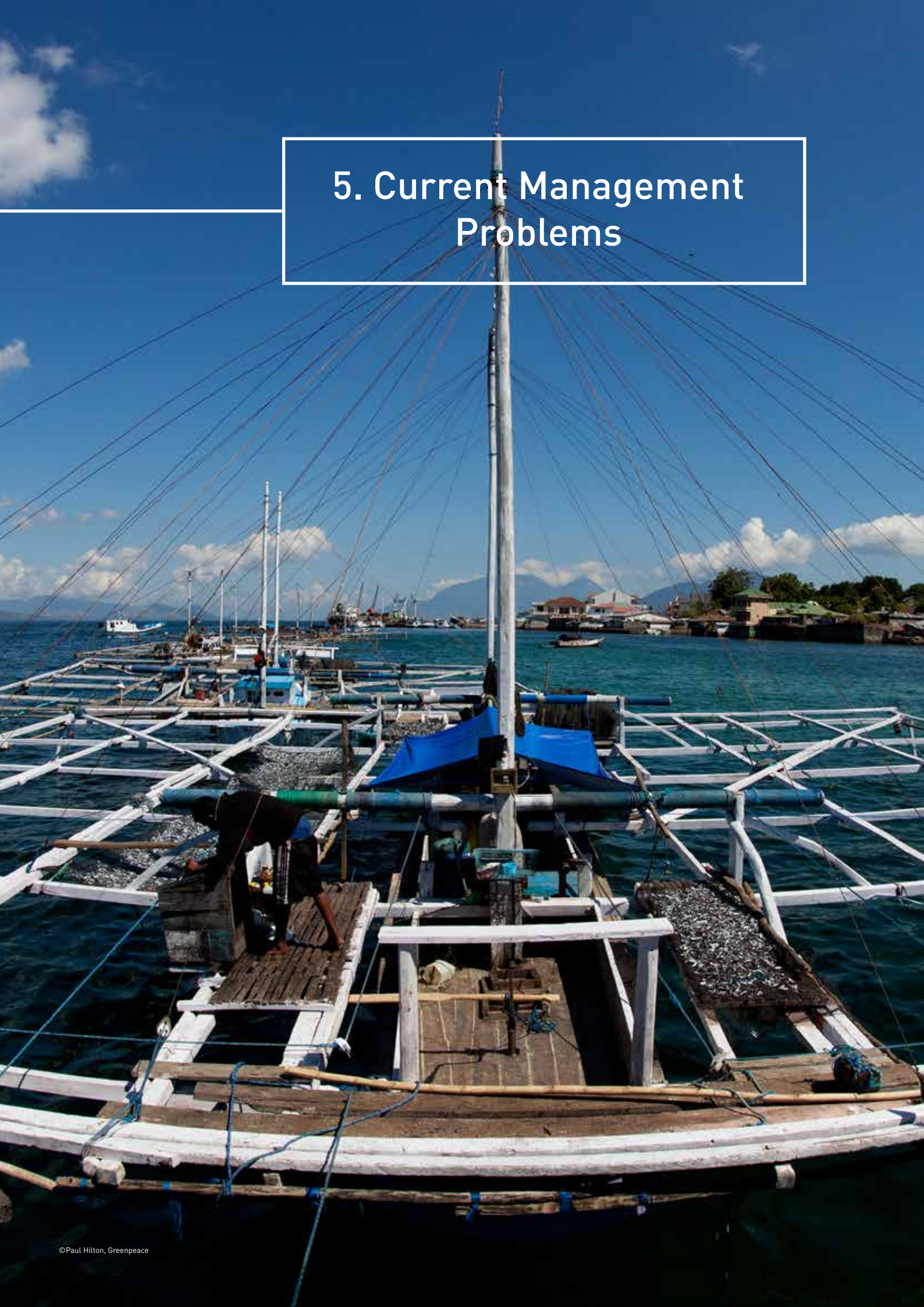
required to address the special issues faced by baitfisheries. This contention is supported by an Indonesian fisheries management study (Dudley and Ghofar, 2006) that stated there is a need for “more emphasis on clearly defined fisheries as opposed to management based on political boundaries.”

It also should be noted that there is a national decree dealing with fishery management plans in Indonesia. Ministerial Decree 29 of 2012 deals with fisheries management plans for capture fisheries. The wording implies that it is mainly oriented to an FMA management plan (i.e. a plan that encompasses all fisheries in an FMA). It describes a fairly lengthy process that starts with the minister appointing a team, that team carrying out resource surveys and other work and culminates in a plan signed by the minister. The applicability of such a scheme for a specific fishery (especially one located in an area that does not have an FMA plan) is uncertain.

On the issue of FMA vs. local management plans, there is another important aspect: the time required to go through the FMA plan process is substantial. A plan for the Arafura FMA has been under preparation since 2008 – but has not yet been approved.

In an attempt to reconcile the various considerations relating to fishery-specific management plans and FMA management plans, a view expressed by the staff of an NGO is quite helpful: local baitfishery management plans prepared in the near future can be incorporated into FMA type plans that may be prepared in the longer term.

5. Current Management Problems



5.1 A Major Difficulty

In Section 1.2 above, the 2012 Baitfishery Management Think Tank was described. That meeting discussed a major problem of baitfishery management in Indonesia: the practicality of improving the management of fisheries supplying bait that are surrounded by fisheries that are poorly managed. The consensus of opinion from the gathered experts is reflected in the text of the meeting report:

“The management of baitfisheries that are surrounded by many poorly managed coastal fisheries is a situation especially prevalent in Indonesia. Although “working with local NGOs” has been cited as a possible approach, this may not necessarily address some of the underlying issues – including the huge size of the task of improving the management of the many fisheries in some areas. The baitfish meeting felt that perhaps the best approach would be to encourage work in one area where there are favorable conditions to improve the management of several fisheries (including baitfisheries) - as an example of what could be done in other areas.”

Following from that information, the recommendations given in this report for improving baitfishery management in Indonesia are based largely on that general strategy: working initially in one or two locations where there is the greatest chance of success.

5.2 Lesson Learned in Management Baitfisheries in Other Areas

As can be seen from Table 1 (page 22-24) and appendices 2-4, the management of baitfisheries in Indonesia has been minimal. In this situation, an examination of baitfishery management in other countries could be of benefit for Indonesia. Although a full examination of the subject is far beyond the scope of the present study, some points (mainly from the Western Pacific), should be made.

Some useful information on the management of the 11 most important baitfisheries in the world today are found in the Appendix of “The Management of Tuna Baitfisheries: The Results of a Global Study” (Gillett 2012). It includes management issues, main institutional and procedural difficulties, research results, and management tools used. That information provides context for some of the baitfish management

issues of Indonesia. Another very useful document is “A Review of the South Pacific Tuna Baitfisheries” (Dalzell and Lewis, 1989).

Most of the main baitfish species found in Indonesia, are also those species important in Papua New Guinea and the Solomon Islands – where a substantial amount of baitfish research has occurred. The management implications of that research could be quite relevant to Indonesia. Box 3 and 4 are examples.

The nature of many baitfish species found in Indonesia and elsewhere, points to relatively high productivity and some degree of resilience to fishing: low trophic level, highly fecund, with rapid growth, and relatively short lifespans. In general, these fish are considered to be “r-selected” (i.e. they allocate a relatively large portion of their resources to reproductive activities) and can typically be fished at younger ages and at higher levels of fishing mortality. These “r-selected

Box 3: Baitfish Catch per Unit of Effort in the Solomon Islands

The use of baitfish in the Solomon Islands corresponds to the rise and fall of pole-and-line fishing in the country. Barclay and Cartwright (2006) show that annual baitfish catches in the period 1973-1998 ranged from 376 tonnes to 2,498 tonnes, while the annual catch in the 5-year period 2000-2004 ranged from 225 to 828 tonnes. Trends in catch per unit effort have been used to study the issue of baitfish stock depletion. Barclay (2008) states that the CPUE remained largely unchanged throughout 27 years of baitfish operations. Even if 1970s data is discounted due to deficiencies in the reporting and monitoring systems rectified in the 1980s, there is nearly 20 years of fishing without a sustained CPUE decline.

Box 4: Baitfish Population Structure in Papua New Guinea

Work in Papua New Guinea on anchovy baitfish species important in Indonesia (i.e. *Encrasicholina heteroloba*, *E. devisi*) in the western Pacific indicates a degree of genetic isolation between the various baitfishing grounds (Daly and Richardson, 1980). This suggests that each lagoon baitfish population of those species be managed as a self-recruiting meta-population, rather than on a much larger geographical basis.

species” should also have a quicker recovery from overfishing than those based on fish that place higher emphasis on the strategy of survival to reproductive age (“k-selected”).

There have been many assessments of baitfish resources in the various baitfisheries of the Pacific Islands region over the last 30 years by SPC, ACIAR, FAO, NMFS, national governments and others. It appears that the only case where this work had an impact on management measures was in Papua New Guinea where a drop in catch per unit of effort (CPUE) led to restrictions on some of the baitfishing grounds (Skipjack Programme, 1984). This carries the suggestion of the importance to management of monitoring trends in CPUE. Trends in catch and CPUE have the additional advantage that they are simple, easy for developing country managers to use, and are readily understood by fishers and the general public.

5.3 The Need to Monitor Baitfisheries

One of the major conclusions of the global study of baitfish management concerned monitoring. The report of the study (Gillett 2012) stated:

“One general objective that is recognized as being very important in the major baitfisheries of the world is the need to avoid any overfishing of the target resource. To do this usually requires a knowledge of catch and effort in the fishery, along with species composition.....It has become apparent during the present study that perhaps the only improvement that is broadly applicable to the management of most baitfisheries concerns monitoring. It seems that the relatively simple process of collecting and analyzing baitfishing catch and effort data would help improve the management of most of the world’s baitfisheries by providing key information for decision making.”

The 2012 “Baitfish Management Think-Tank” also commented on the issue of monitoring – and specified the essential components of a baitfish monitoring program. That meeting indicated the types of data that should be collected and reported to monitor baitfish fishing operations: date, location, gear, day or night, number of sets, number of buckets loaded aboard per day, and primary species.

5.4 Mitigating Baitfish Shortages for Pole-and-Line Tuna Fishing

5.4.1 Baitfish Shortages

Many of the pole-and-line fishing operations in Indonesia experience shortages of bait, at least seasonally. For the three locations visited during the present survey (according to stakeholders interviewed), the situations can be summarized as:

- Larantuka – Seasonal baitfish shortages and a declining trend in baitfish CPUE since 2000.
- Sorong - Bait shortage does not seem to be a major problem, except for around the full moon and in poor weather. There are reports, however, of competition among pole-and-line vessels for bait supplies.
- Bitung - Seasonal bait shortages, and at least some reports of declining baitfishing CPUE in recent years.

The fact that the fairly expensive operation of culturing of baitfish is being attempted at all three of the above locations reinforces the contention that baitfish shortages are a major constraint at all the sites visited. Ledbitter (2012) summarizes the larger situation across eastern Indonesia: “The uncertain availability of bait is a major constraint on the viability of pole-and-line industry. This is a consistent view across all areas, from different studies and over long periods of time (decades).”

In examining the issue of baitfish shortages, a number of observations can be made:

- Many reports on baitfisheries in Indonesia comment on baitfish shortages.
- The most comprehensive studies focussing on baitfish shortages point to natural variation in abundance and/or increased use of bait as food – rather than simply over-exploitation by baitfishing. Box 5 summarizes the results of one baitfishing study.
- The solutions offered for mitigating baitfish shortages for the pole-and-line fleet include using alternative baitfishing techniques (e.g. boke ami gear), restrictions

on the non-bait use of baitfish, culturing baitfish, and reduction of wastage in bait handling, bait storage and bait utilization. These mitigating measures are considered in sections below – after a discussion of the baitfish requirements of a pole-and-line fishery.

5.4.2 Baitfish Requirements of a Fishery

The baitfish requirements of pole-and-line fishery depends on both the size of the fishery and the efficiency of bait utilization. This is shown in Table 2, where it can be seen that the efficiency of bait utilisation (i.e. tuna to bait ratio) has a very large impact on the bait requirement of a fishery

Table 3 shows the ratios¹ from various fisheries in the central and western Pacific. From both tables it can be seen that the tuna-baitfish ratios at the height of the Pacific Islands pole-and-line fisheries were around 32:1.

During the present survey, some information on ratios² was offered by stakeholders:

- **Larantuka:** For the baitfish-tuna ratio, one company suggests 1:11 (based on 7 buckets a day usage for 1.5 mt average daily tuna catch), while another company thinks that the ratio is 1:20 (based on fishing knowledge).
- **Sorong:** A fishing operations manager indicated that his boats take on 90 to 100 buckets of bait. He stated that a bucket contained about 10 kg of bait (but later in the interview, revised that amount to 5 kg). On the average that bait results in about 3 mt of fish, or a bait to tuna ratio of 1:6 – but the manner in which this was stated (and the poor ratio) indicate that the manager was not used to thinking in terms of ratios or kgs

¹ As the tuna-to-bait ratio is often used in discussions of pole-and-line fishing, it should be noted that there can be difficulties in comparing ratios between fisheries, especially between those fisheries where bait is purchased (where pre-purchase mortality is not considered, plus the purchased bait is “hardened” bait with higher survival characteristics) and those where the pole-and-line vessel catches its own bait (where mortality estimates typically encompass the entire process from capture to use).

² This is the tuna to baitfish ratio, the inverse of the baitfish to tuna ratio.

Table 2: The Baitfish Requirements of a Pole-and-Line Fishery

Tuna to Bait Ratio ↓	Size (tonnes) of Pole/Line Fishery				
	50	100	300	8,000	15,000
	Bait Required in Tonnes				
12:1	4.2	8.3	24	667	1,250
15:1	3.3	6.0	19.9	533	1,000
20:1	2.5	5	15	400	750
30:1	1.7	3.3	10	267	500
50:1	1	2	6	160	300
100:1	0.5	1	3	80	150

Source: Kearney and Rivkin (1981)

**Table 3: Information on Tuna to Bait Ratios
Obtained by Various Pole-and-Line Fishing Operations**

Area	Information on Tuna to Bait Ratio	Source
PNG	In a study which analyzed 13,000 daily catch forms submitted by live-bait pole-and-line boats operating in Papua New Guinea in 1972 and 1973 it was determined that 41,393,000 kg of skipjack was caught and the total quantity of bait taken was 1,373,046 kg, giving a tuna-to-bait ratio of 30 to 1.	Kearney (1977)
Solomon Is.	Pole-and-line catches peaked in 1979 with 23,807 tonnes of skipjack. In 1979 a total of about 607.4 tonnes of bait was used, or about 39 kg of skipjack per kg of bait.	Argue and Kearney (1982)
Fiji	In February and March 1978, the Ika Corporation fleet averaged 31.1 kg of skipjack per kg of bait	Ellway and Kearney (1981)
SPC Area	On the SPC Skipjack Programme research vessel (1997-1980): <ul style="list-style-type: none"> • The corrected tuna-to-bait ratio of anchovies throughout the SPC area was 32.3 • The corrected tuna-to-bait ratio of sprats throughout the SPC area was 34.7 • The corrected tuna-to-bait ratio of sardines throughout the SPC area was 27.4 	Skipjack Programme (1981a)
Palau	The annual bait catch in Palau in the period 1964 to 1972 varied from 21,776 kg to 222, 206 kg; averaging about 140,000 kg. The tuna catch in those years averaged 3,713 tonnes. The tuna to bait ratio was therefore 26.5	Muller (1977), Lawson (1998)
Hawaii	The ratio of skipjack tuna to baitfish (<i>Stolephorus purpureus</i>) in the Hawaiian pole-and-line fishery averaged 23.1 over the period 1950 to 1972.	Yoshida et al. (1977)
Japan	The ratio of skipjack tuna to baitfish (mostly <i>Engraulis japonicus</i>) in the Japanese pole-and-line fishery averaged 9.7 over the period 1957 to 1971.	Yoshida et al. (1977)

Source: Gillett (2011)

Box 5: Some Results of the ACIAR Baitfish Study

The ACIAR study of tuna baitfish in eastern Indonesia was carried out 1995-2000 and involved (1) Analysis of existing baitfish catch record data for Sorong, Ambon, Bacan and Bitung. Data were from as far back as the mid-1970s, and (2) Stock assessment of anchovies in the bait grounds of Sorong, Ambon and Bacan. The study used primarily the daily egg production method to estimate anchovy biomass. The report of the study stated:

“The data suggests that natural fluctuations in anchovy biomass exceed the amount of baitfish taken by the fisheries. Periods of short supply will occur even at low exploitation rates. The data have shown that the daily tuna catch rates have declined since 1991 along with the amount of bait being used. We have shown that this is unlikely to be due to overfishing the baitfish resource. Rather, it appears to reflect the increasing demand for these fish by humans, so that during periods of naturally low baitfish abundance, the pole-and-line fishery cannot get sufficient bait.”

“Production of baitfish in the Bitung area attained 5,110 mt/yr, and the baitfish demand by 40 pole-and-liners based in Bitung was only 3,720 mt/yr. A shortage of baitfish occurred in this area because the peaks of tuna and skipjack fishing seasons are not coincident with the peaks of baitfish numbers.”

Source: ACIAR (2001)

- **Bitung:** A fleet owner indicated that his bait to tuna ratio is 1:7, and recognizes that it is small compared to pole-and-line fisheries in other countries

The above information supports observations in other reports (e.g. Leadbitter (2012); Ingles et al. (2008); Itano (1993)) that Indonesian pole-and-line vessels have poor tuna to bait ratios. This can be improved by modifications to bait handling, bait storage and bait utilization.

5.4.3 Reduction of Wastage in Bait Handling, Bait Storage and Bait Utilization

For reasons mentioned in Section 1.2 above, the present survey was unable to directly observe baiting operations at the three locations visited. However, through interviews with bagan operators, pole-and-line fisheries fleet managers, and (at Larantuka) NGO-employed enumerators it was possible to learn much about how the bait was handled and used. In addition, videos showing bait handling were available for Larantuka and Sorong.

The information collected at the three locations on baitfish handling and mortality is given in appendices 2-4. From descriptions of the baitfish bucketing process, it can be concluded that it is quite rough:

- **Larantuka:** The WWF enumerators indicate that bait is dry-scooped in the transfer process.
- **Sorong:** A 15 minute PT Citraraja video of their baitfishing shows that for the transfer bagan-vessel, bait is semi dry-scooped (i.e. as the scoop net is raised out of the bagan net, some baitfish remain underwater, some are raised out of the water) into a bucket half full of water and then passed to the bait well.
- **Bitung:** The baitfish transfer (bagan>pole-and-line vessel) as described by pole-and-line vessel operators and bagan owners consists of crowding the bait in the bagan net and using the transfer bucket as a scoop, without the use of a scoop net (i.e. fairly rough handling).

Many past studies of baitfish in Indonesia have pointed to rough handling: Itano (1993), ACIAR (2001), and SPC (2008). The 2012 “Baitfish Management Think-Tank” also commented on the subject:

“Baitfish mortality during capture, handling, and storage is important. The reduction of such mortality (i.e. minimization of wastage) should be considered a legitimate objective of the management of some baitfisheries.... Baitfish survival in some baitfisheries could be improved by following best practice guidelines to reduce wastage and mortality throughout bait catching and tuna fishing operations.”

Box 6: Reducing Bait Wastage in Indonesian Pole-and-Line Fishing**1) Baitfish handling:****Allowing baitfish time to settle before transferring.**

- Whenever possible, allow the bait as much time as possible to settle after the bait net has been hauled before transferring to the catcher. This will reduce stress induced mortality and allow time for the weakest bait to die before loading.
- For multiple day trips, or when the distance to fishing grounds is great, load the bait during daylight hours. Bucketing can often be accomplished without scooping the bait and survival is higher than for night loaded bait.

Reducing the amount of bait loaded per bucket.

- The pole-and-line fisheries of other areas normally load only 1.5 to 2.0 kg of bait per bucket of seawater which allows the bait enough water for adequate dissolved oxygen levels and reduces rubbing and scale loss in a large scoop net. This is more work for the crew, but should always be practised when loading bait caught by the vessel.

Minimizing contact of the fish with the scoop net.

- Train fishermen in scooping and bucketing techniques that minimize net abrasion and scale loss.

2) Baitfish storage:**Improve lighting systems for bait tanks.**

- A low wattage light above or submersed in the bait well should always be used if the bait is kept overnight. Normally, the bait is loaded at night and a soft lighting in the well will promote settling, reduce stress and prevent the baitfish from colliding with the sides of the well.

Box 6: Reducing Bait Wastage in Indonesian Pole-and-Line Fishing (continued)**Improve water quality in the bait wells.**

- Install water circulation systems for all bait wells. The small 10 GT pole-and-line have pumps that operate water sprayers when fishing. Pumps could be adapted or upgraded to supply circulation for the bait wells.
- Larger vessels should have bait circulation systems upgraded to operate continuously and circulate water efficiently. This will maintain water quality to a high standard and will also allow greater densities of baitfish to be loaded.

Determine optimal bait loading levels per cubic metre of bait hold

- This depends on the type of water circulation system used
- Fishermen must be educated in this regard.

Clean wells if bait is held for long periods.

- If a significant quantity of dead bait accumulates at the bottom of the bait well, it should be removed while trying to minimise disturbance to live baitfish. Entering the well should be avoided if possible.

3) Baitfish utilization

During fishing operations, maximizing the ratio of catch per bucket of bait chummed should be stressed:

- Careful school assessment.
- Schools or FADs should be carefully selected and chumming halted quickly if the school does not respond within a reasonable amount of time.
- Use a minimum amount of bait per school.
- Concentrate baitfishing operations on the strongest and most desirable (to tuna) species of bait available

Source: Itano (1993)

Bait wastage can be thought of as having three components (summarised in Box 6):

- 1 Poor baitfish handling: for many of the bait species commonly used in Indonesia (e.g. the anchovies *Engrasicholina devisi*, *E. heteroloba*), any contact that the fish have with a hard surface (e.g. side of bucket, net, other fish) during the transfer operation will tend to result in scale loss, contributing to mortality.
- 2 The manner in which baitfish are stored aboard a pole-and-line vessel also has a large impact on mortality. This includes the kind of circulation in the bait tanks, lighting of the tanks, and density of baitfish in the tanks.
- 3 The third form of bait wastage is more subtle: using more bait than necessary to chum a tuna school. This involves the fishing skill of the pole-and-line vessel captain and the crew doing the chumming. This problem is manifested in the relatively poor tuna to bait ratio typical of pole-and-line fishing in Indonesia (Section 5.4.2 above).

Of the three forms of bait wastage, it appears that the easiest to address is the bait handling during the transfer from bagan to pole-and-line vessel. A basic problem in Indonesia is that the pole-and-line fishers pay for the bait by the bucket and have an incentive to pack as much bait as possible in a bucket. A contributing problem is that pole-and-line vessels compete for limited bait supplies and therefore there is a rush to load bait quickly.

Fortunately, the issue of bait wastage in Indonesia was well-studied by a very competent individual with considerable experience with pole-and-line fishing and baiting in many countries. The suggestions for improvement offered in Itano (1993) remain as valid today as two decades ago.

The objective of the Itano study was to examine the utilization of live baitfish by the Indonesian pole-and-line fishery in order to determine whether changes could be instituted to improve the viability of the industry. In summary, the recommendation can be divided into three categories that correspond to the three types of bait wastage described in Box 6.

Some of the above features are shown in Appendix 5 which is a description of western and central Pacific baitfishing prepared for improving aspects of baitfishing in the Maldives – where bait handling is also quite rough.

5.4.4 Culturing of Baitfish

Cultured Baitfish at the Locations Visited

Information on the use of cultured bait was sought in the three locations visited. This included trying to get information on past experience, problems encountered, pricing, interest in its use, and viability. This can be summarized as:

Larantuka:

- There is certainly interest in using milkfish as bait, but the pole-and-line fishers are unconvinced of how good the bait is (i.e. baitfish-tuna ratio).
- The selling price of milkfish by the PT Mitramas operation in Larantuka (IDR 500,000 per bucket, according to the farm manager) compares favorably with wild bait during times of bait scarcity.
- A Jakarta-based PT Mitras manager said the operations would be viable except for the necessity to charter a plane to get fry from Bali: “Viable for part of our baitfish requirements if we can produce fry in Larantuka”.
- There is some question of what to do with milkfish that reach harvestable size during the January-March period when there is little pole-and-line fishing.

Sorong:

- Although baitfish is plentiful in the area, the interest in milkfish stems from (a) the poor bait catches around the full moon and during rough weather and (b) the reduced amount of baitfishing area to the expanding numbers of MPAs.
- PT Citraraja has carried out cultured milkfish trials in cooperation with a local fisheries academy, using fry purchased in Makassar (IDR 30 per fingerling). The two trials suffered high mortality (about 50%).
- PT Radios has trialled the culture and use of milkfish as bait with one pilot pond near the company base. Staff of the company state they purchased fry at IDR 65 apiece and the cost of raising them to baitfish size is IDR 250 apiece. The company is still considering the results.

- There is a milkfish culture operation being developed near Sorong City for primarily food for consumption. The ponds are still under construction – and they may total 100 hectares in the future.

Bitung:

- Bailey (2012) stated there was lots of talk about aquaculture to help supplement supply, but the planned aquaculture is for milkfish, which the fishers said does not work as well as anchovy.
- A fleet owner stated that his company trialed cultured milkfish. The cost of the fingerlings (from Bali) was quite high and the cost per bucket was about IDR 500,000 per bucket. His fishermen liked milkfish for pole-and-line bait.
- A fleet manager has heard of the culture of milkfish, but he is worried about the slow growth rate of milkfish.
- Staff of DKP Bitung City are aware that some culture of milkfish for bait has taken place in the Bitung area – but this was for longline and handline bait, rather than for pole-and-line bait.

At all three locations there has been at least some experience in culturing and using milkfish as bait – but apparently no other species has been trialed. Mindful that there may be considerable commercial secrecy, the results of those milkfish trials seem



Figure 2: The Milkfish Culture Ponds in Larantuka

somewhat inconclusive: the companies involved appear neither very negative nor madly enthusiastic about the results. Other observations are:

- Most of the companies that produce milkfish for baitfish cite their production costs, but it is uncertain what the selling price to fishers will actually be and uncertain that interested pole-and-line vessels will actually pay that amount.
- Fishers and fishing companies in the locations visited are still uncertain if milkfish is a good bait (i.e. favourable tuna to baitfish ratio) and wonder about its mortality. Judging from experience from the central and western Pacific (given below), milkfish score nicely on both issues.
- The economics of operating a milkfish culture operation for baitfish are negatively affected by the fact that there is only a large demand when wild baitfish are scarce.
- There is at least some sentiment on the part of private companies involved with baitfish culture, that the government should take over the culturing once the company trials are completed.
- There is some logic in having the milkfish production under the control of the same entity that controls the pole-and-line fishing – to assure availability of cultured bait when it is required (i.e. over-coming the problem of too much bait when it is not needed, not enough when it is needed).
- The handling of cultured milkfish mirrors the rough handling of wild baitfish. Much could be done to improve the survival of cultured milkfish – changes that would have a positive impact on the feasibility of culturing baitfish.

Some of the recent literature on tuna fishing in Indonesia (i.e. Ingles et al. (2008), Lead-bitter (2012)) examines the issue of whether milkfish (or other species) is the most appropriate one for baitfish culture.

The Experience in the Central and Western Pacific

In the tropical central and western Pacific there has been much experience in the culture of baitfish for pole-and-line fishing. This has been mainly for milkfish and

mollies (*Poecilia mexicana*). Large-scale culture has been undertaken in Kiribati and French Polynesia. Smaller projects have been carried out in American Samoa, Fiji, Palau, Tonga, and Western Samoa. In other locations (e.g. Hawaii, California) other species have been raised for baitfish, including tilapia. This culturing baitfish experience spanned about 30 years.

There is no longer any baitfish culture in the Pacific. One obvious factor is that the pole-and-line fleets have largely disappeared, but even when the fleets were thriving there was considerable reluctance on the part of pole-and-line fishers to purchase cultured bait at any cost – those vessels (unlike in Indonesia) caught their own bait. On this point, Itano (1993) notes: “Baitfish culture has not been economically viable in other regions but Indonesia is unique in that fishermen are accustomed to purchasing bait”. It also should be noted that all the Pacific culture operations were government or aid-sponsored and that few aquaculture projects for any purpose (government or private) have enjoyed much success in that region.

Of considerable relevance to the Indonesia situation, there has been an analysis of feasibility of baitfish culture for pole-and-line fishing in the central and western Pacific. Much of the information in Kearney and Rivkin (1981) is still quite valid. That report (available at <http://www.spc.int/fame/en/fame-digital-library>) outlines a methodology for determining the maximum acceptable price to fishers for cultured bait. It also gives some features of the use of milkfish as pole-and-line baitfish:

- Sea trials indicate milkfish are highly attractive to skipjack, while mollies are not nearly as good.
- Based on SPC trials, the estimated tuna to bait ratios from milkfish under commercial fishing was 56:1.
- Both milkfish and mollies have very high survival in bait tanks.

Work by FAO with the cultured baitfish in Kiribati in the late 1980s showed that milkfish in good condition produced superior tuna fishing results compared to using milkfish that were stressed.

Concluding Comments on Baitfish Culture in Indonesia

Several of the unknowns of baitfish culture in Indonesia can be clarified by the experience from the central and western Pacific. In terms of the type of fish to be selected for culture, milkfish is very likely to be the most appropriate species. When treated and used properly, milkfish has very good survival in bait tanks and a very favorable tuna to bait ratio.

Baitfish culture has not proven to be viable in the central and western Pacific, but some of the conditions are more favorable in Indonesia: a tradition of pole-and-line fishers purchasing baitfish and heritage of successful aquaculture for other species/purposes.

The economics of baitfish culture are intimately tied to the economics of pole-and-line fishing - which could be getting better or worse, depending on premiums received (if any) for pole-and-line tuna.

Several Indonesian companies now have experience in the culture of milkfish for pole-and-line bait. They are likely to have considerable insight into the feasibility of baitfish culture, and therefore in a position to decide whether to proceed (and shoulder the costs) of milkfish culture. It would seem that if the economics of baitfish culture are dubious, the companies would be enthusiastic about the government taking on milkfish culture as a service to the industry.

From the above, there is the suggestion that if pole-and-line companies do not proceed, some level of government may need to decide on whether to provide assistance to bait culture - which may equate to promoting an activity whose feasibility is doubtful. Alternatively, another perspective on the situation (expressed in Moore (undated)) is that this would be an opportune area to support because of its immediate and significant impact.

5.4.5 Other Possibilities of Mitigating Baitfish Shortages

Other possibilities of mitigating baitfish shortages are the use of alternative baitfishing techniques (e.g. boke ami gear) and placing restrictions on the non-bait use of baitfish. Another approach would be to limit the fishing effort on target baitfish species - but that would be appropriate only if those species are over-exploited and that is dealt with in other parts of this report.

Alternative baitfishing techniques

Alternative baitfishing techniques in Indonesia are mainly about the pole-and-line vessel catching its own bait (i.e. not from bagan purchase). This often refers to Japanese-style boke ami gear. In this report, because beach seines and lampara gear are occasionally in Indonesia for baitfishing, they are not considered “alternative techniques”.

Boke ami gear was widely used in the major baitfisheries of the central and western Pacific, such as Papua New Guinea and the Solomon Islands. At the height of the Pacific Islands pole-and-line fishery in the late 1970s about 2,500 tonnes of baitfish were caught annually by boke ami gear (Gillett 2011).

There has been considerable interest in the issue of alternative baitfishing techniques for the Maldives pole-and-line fishery. In 2013 a project sponsored by the World Bank produced a report that described in detail the boke ami gear used in the central and western Pacific. That report (Gillett 2013) has been modified and is given as Appendix 5 to this report.

Some comments are required on the boke ami technique:

- There are some reports of boke ami fishing in Indonesia, but the technique does not appear to be very widespread.
- SPC has operated a research pole-and-line vessel in Indonesia on several occasions during the period 1978-2008. They generally had good results with boke ami gear. SPC (2008) states: “The [2008] cruise was blessed with almost continuous good bait in plentiful supply, either from capture by the vessel itself using standard boke ami gear or purchased from bagans.”
- Boke ami gear does not create bait. If a baitfish population (e.g. anchovy) is over-exploited by bagan fishing, simply adding boke ami gear will not be the solution to the problem. The advantage of boke ami gear in this situation is if there are other baitfishing locations that are not exploited by bagans. However, as Lead-bitter (2012) notes “More than likely, once any new grounds were developed then other user groups would move in if access is not restricted”.

- It is somewhat ironic that currently in a few Pacific Island countries, attempts are being made to introduce bagan baitfishing gear to improve baitfish catches in support of re-viving pole-and-line fishing.

Placing Restrictions on the Use of Baitfish

The fish species used as baitfish are also used in Indonesia for a variety of other purposes, including food for human consumption locally (fresh, frozen, dried), for reduction to fish meal, and for export.

Limiting the use of fish for human consumption, especially in favor of use in large scale fishing, can be politically charged - and the implications are best known to Indonesian stakeholders. It should be noted, however, that restricting the local sales for consumption is more sensitive than restricting sales for consumption in other parts of Indonesia or outside the country. In this context, the Maldives has banned the export of bait species since 1993.

In Larantuka at least some baitfish are utilized in a new fish meal factory located elsewhere in East Flores. There may be justification for placing some form of controls on that facility purchasing the same species used as bait fish. Caution is required so that such a scheme does not negatively affect pole-and-line feasibility - such as limiting the options for disposing of a vessel's unused bait.

5.5 Placing Limits on Fishers

In a section above it is stated that, although a fishery management plan can tremendously facilitate the process of management, it does not make the most difficult part disappear: the effective placing of limits on catches or on fishing effort.

At some point placing controls on baitfishing in Indonesia will probably be required (if not required already) - for a variety of purposes, including the mitigation of resource over-exploitation, reducing negative interactions with other groups of fishers, and improving profitability of fishing operations. In other countries, such controls consist of bans on fishing when a specified catch limit has been reached, quotas for individual fishers, and closed seasons. In Indonesia there is no strong heritage of limiting catch or effort through any of those means. Although there are a few examples of such limits under traditional systems, they are not a general characteristic of fisheries management in the country.

It is essential that a fisheries management plan has controls available for use when certain limits are exceeded – hence the importance of identifying appropriate controls for Indonesia's baitfishery at the beginning of the process. In discussions during the present survey, a large number of stakeholders and other sources were questioned on what types of controls could be used when, for example, the target stock shows signs of over-exploitation. The responses were not very satisfactory.

Several government officials stated that fishing effort could be limited by refusing to grant a fishing license. It does not seem that this proposed control would be effective due to little heritage of license refusal and the fact that many fishers (including baitfishers) are unlicensed without negative consequences.

A recent MSC-oriented fisheries improvement project (Poseidon 2013) proposed a fairly elaborate assessment/monitoring scheme for the baitfisheries, but when it comes to applying controls, the report states they are “likely to include, inter alia: spatial and seasonal closures; changes to gear configurations, to minimize interactions with juveniles and at-risk species e.g. hook types, minimum mesh sizes, maximum gear dimensions etc.; non-target species catch limits”. Enquiries during the present survey to senior Indonesian fisheries officials did not result in identifying cases in Indonesia where those cited controls have been effective.

Pole-and-line fishing companies and captains sometimes discount the need for catch controls. They feel that the need for controls could be eliminated by alternative baitfishing techniques and aquaculture. Both are likely to be partial solutions at best.

Several non-conventional mechanisms were also offered as controls or as influences that would reduce the need for controls:

- An NGO indicated that by involving fishers in data collection and analysis, the fishers could see the consequences of excess fishing, and would tend to restrain their own fishing activities – something that seems like wishful thinking.
- The use of alternative livelihoods (i.e. providing baitfishers with other types of income) has also been suggested as a mechanism to reduce fishing. Analysis of a large number of such projects in the Pacific Islands area (Gillett et al. 2008) did not reveal any cases where the use of alternative livelihoods was clearly successful in reducing fishing effort.

- The use of habitat enhancing structures: it was been suggested that placing items on the lagoon floor (e.g. “fish houses”) could produce more habitat and therefore more baitfish. This would appear to be only logical where the important baitfish populations are limited by lack of physical relief – which does not appear to be the case for the important baitfish species.

The above seems to suggest that baitfish management in Indonesia is in danger of being reliant on non-existent controls. To overcome this fundamental problem, it is strongly recommended that only those controls that have had some degree of success in Indonesia be proposed for the baitfish management scheme.

Following from the above, an alternative control is proposed. Several NGOs active in marine conservation in Indonesia have established marine protected areas (MPAs). MPAs have been established in the Raja Ampat area by the local government and The Nature Conservancy (TNC) and are likely to soon be established in areas off East Flores by the local government and WWF. Those MPAs are close to the baitfishing grounds of the pole-and-line fleets based in Larantuka and Sorong. In Section 3.2 above it is shown that both bagan fishers and fisheries officials believe that the MPAs have reduced baitfish catches in the Raja Ampat area. Interviews with bagan fishers that operate in Raja Ampat indicate that the enforcement of no-take areas in Raja Ampat is very effective. The above suggests that MPAs could be an appropriate control for use in baitfish management.



Figure 3: Baitfish sales in Sorong, for retail (left) and for food (left and right)

MPAs, however, are far from an ideal management control. From the fishing operation perspective they are not very economically effective for reducing effort. In some cases the effects of an MPA could equate to squeezing the same amount of fishing into a smaller area. For baitfish management, an MPA could be considered a blunt management tool - but there appear to be few alternatives for Indonesia.

5.6 Baitfish for Pole-and-line Fishing versus Food for Consumption

In Section 5.4.5 above some considerations are given on restricting the use of baitfish³ as food for human consumption - as a possible mechanism for easing baitfish shortages (probably not such a great idea). That is part of a larger issue of partitioning the catches of bagans⁴ between use as bait and use as food for human consumption.

In terms of the trends in the partitioning of baitfish catches, a range of stakeholders in each of the three sites visited during the present survey indicated that the portion of bagan catches used for human consumption has grown in the last few decades. This trend is also suggested in the older ACIAR baitfish studies which pointed to increased use of bait as food (ACIAR 2001).

Judging from observations at the three locations of the present survey, the current partitioning of bagan catches between use as bait and food is complex. In appendices 2-4 the situations at the three sites are detailed. In summary, the catch of most baitfishing bagans is partitioned between baitfish and food, with the proportion depending on the various operations, prices, species and seasons. Often prices are higher for baitfish⁵, except for the weak species and species especially valued for

³ For simplicity, fish that are commonly used for bait and human consumption are called baitfish in this report - without trying to buy into the argument if it is a case of using bait as food or of using food as bait.

⁴ Catches from other types of baitfishing (e.g. beach seining for baitfish) are included with bagans in this section.

⁵ Comparison of prices paid (bait/food) are complicated by bait being sold in buckets (size not determined during survey), whereas the same species sold as food are often sold in baskets (size not determined during survey).

Box 7: Indirect Interactions Between Baitfisheries and Food Fisheries in the Western Pacific

One of the chief concerns expressed by traditional reef owners and subsistence fishermen in Fiji was that commercial boke-ami net baitfishing may affect the numbers of reef fish by removing the main food source of the reef fish. This concern has been widespread in Pacific Island countries. Research indicates however, that in Solomon Islands and Kiribati, such interaction between baitfishing and reef fishing through the food chain is likely to be minimal; only pelagic and benthic-pelagic predators were major consumers of baitfish in Solomon Islands and Kiribati, and these fishes formed only a small proportion of the catches of the subsistence fisheries. In Fiji, however, the results showed that the possibility of real or potential trophic interactions between the fisheries in Fiji must be considered seriously, particularly with regard to carangids and sphyraenids. Furthermore, drop-lining by tuna fishermen in lagoons during baitfishing may have detrimental effects on subsistence and artisanal fisheries by removing fish that would otherwise be available for local villagers.

food. Baitfish on some pole-and-line vessels that is not used for tuna fishing is sometimes sold for food.

There is also a geographic dimension to the partitioning between baitfish and food. There is bagan fishing in most areas of Indonesia, whereas bagan fishing for pole-and-line baitfish is restricted to eastern Indonesia. In most baitfishing areas of Eastern Indonesia, there are also many non-baitfishing bagans (i.e. fishing only for food).

It is important to note that the above discussion refers mainly to direct post-harvest baitfish/foodfish interactions (i.e. that which occurs in the market). The issue of how baitfishing affects food fish at the trophic level has been studied by an ACIAR project. Some of the results are given in Box 7.

The above section serves to draw attention to the fact that the partitioning of the bagan catch between bait and food is a large issue that is likely to grow in significance. In the pole-and-line industry's quest for sufficient baitfish, any initiatives that promote the concept that baitfish should receive preference over food should be carefully considered, as there is the possibility that it may tarnish some of the positive social credentials of pole-and-line fishing. The idea that industrial tuna fishing is affecting the food security of coastal communities could be a very sensitive issue.

5.7 Management Authority: the district versus the central government

Indonesia currently has 34 provinces and about 500 districts. A senior central government fisheries official has indicated that baitfishing for pole-and-line fishing occurs in about 60 districts (B.Eskandar, per.com.).

Prior to 1999 much of the authority for the management of fisheries was vested in the central government. The enactment of Law Number 22 of 1999 on Regional Governance had major implications for fisheries management in Indonesia. Of special relevance are:

- Article 2: The territory of the Unitary State of the Republic of Indonesia shall be divided into autonomous Provincial Regions, District Regions, and Municipal Regions.
- Article 3: The area of Provincial Regions shall consist of inland area and marine area of twelve nautical miles measured from the coastline toward the open sea or island waters.
- Article 10: Regions have the authority to manage national resources located in their area and shall be responsible to maintain the environment conservation in accordance with laws and regulations. Regional authority in marine areas as intended in Article 3 shall cover exploration, exploitation and management of marine wealth to the extent of the aforementioned marine area boundaries. The authority of District regions and Municipal regions shall extend one-third of the marine areas of the Provincial Regions.

Since Law 22 of 1999 there have been other legal instruments that have modified the situation with respect to the management authority that districts have within four nautical miles of their shores.

Currently, it is not as simple as the districts having autonomy in fisheries affairs within four miles (i.e. the bagan fisheries being managed by the districts). During the present survey, discussions with fisheries officials at the district, province, and national level lead to the conclusion that the current situation for fisheries management inside four miles is a complex sharing of authority between levels of government that has evolved over the last decade, and involves many considerations including those relating to financing and institutional

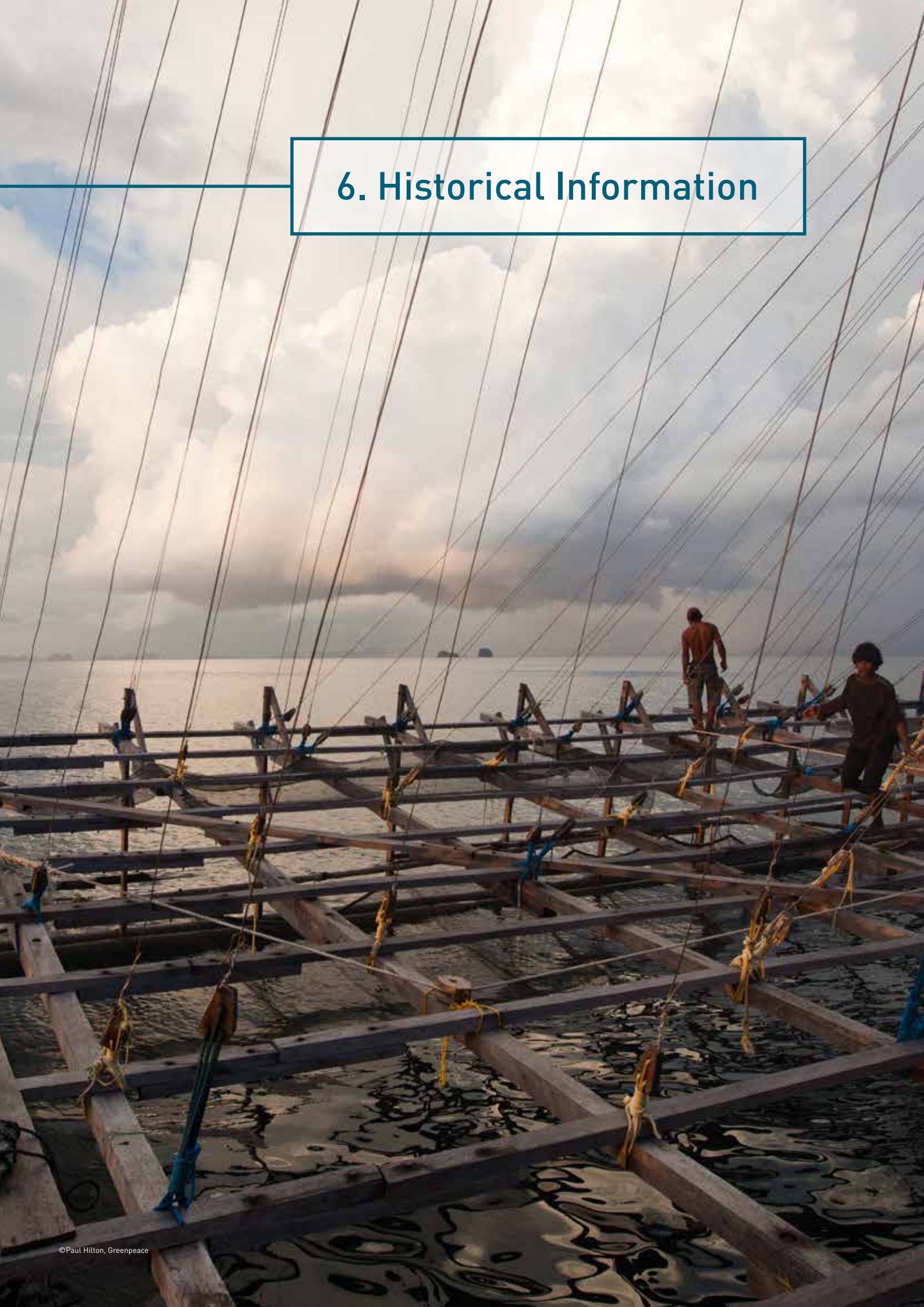
capacity. The reality is that the central government agencies have the skills/experience/money for management of fisheries activities - and because of that, much management at district level is carried out by the central government because they are able to do it. It is also an evolving situation.

The situation encountered at Bitung by the present survey illustrates what seems to be the uncertain nature of the sharing of fisheries management authority:

Departemen Kelautan dan Perikanan (DKP) of Bitung City was asked what would be the management response if a major drop in baitfishing CPUE should occur. They indicated that there would be a limitation of fishing gear or of fishing season. When asked how this would occur, they indicated “by the central government”. When asked about the district’s management authority inside four nautical miles, the response was unclear.

There is also the issue of how fisheries management plans at the district level relate to management plans prepared at the FMA level. This was explored in Section 4.2 above. The approach that will be taken in this report is that local baitfishery management plans prepared in the near future can be incorporated into FMA-type plans that may be prepared in the longer term.

6. Historical Information



From the comments on required baitfish research made during the present survey by many individuals with baitfishery management responsibilities and those made in various documents, there appears to be a significant amount of “reinventing the wheel”: an expressed desire to carry out research on topics that have already been well-studied. In the heyday of pole-and-line fishing in the world, much research was done on topics such as interactions with food fisheries, basic biological characteristics of particular species, baitfish mortality, and culturing bait. This fact does not eliminate the need for additional research, but it would be quite inefficient to carry out new research in ignorance of past results. The need here appears to be a compilation of previous baitfish research findings, including overall lessons learned.

Over the last half-century a substantial amount of baitfish research has been carried out in Indonesia. This has included work from Indonesian national government agencies, universities, ACIAR, and others. Ingles et al. (2008) cites some of that work:

General reviews of the pole-and-line and baitfisheries: (Gafa 1986, Itano 1993, Naamin 1994, Naamin and Bahar 1994, Naamin and Gafa 1998), description of the fishing method (Subani 1982, Gafa and Subani 1991, Itano 1993), analysis of the bait fish species (Subani 1982, Andamari et al, 1987, Banjar and Talaohu 1987, Banjar and Andamari 1900), surveys in search for live bait to develop the fishery (Rawung 1972) or to find baitfish substitutes (Rawung 1972; Rumahrupute et al 1987, Edrus et al, 1992a, Edrus et al, 1992b), analysis of the pole-and-line fishery to determine efficiency of bait and tunas (Rawlinson et al. 1998).

The above represents just a small portion of the documentation on baitfish for pole-and-line fishing in Indonesia.

There is also a very large amount of literature available on baitfish for countries located just to the east and north of Indonesia: Papua New Guinea, the Solomons Islands, Palau, and Fiji – where much research has been carried out on many of the same baitfish species (e.g. *Encrasicholina heteroloba*, *E. devisi* and others). The Aquatic Resources Bibliography of Papua New Guinea (Kailola 2003) lists 57 baitfish papers, many of which are summarized in the Papua New Guinea Fisheries Resources Profiles (Kailola and Opnai, 1995). That document contains information on the baitfish species present, species distribution, biology/ecology (growth, mortality, maturity parameters and spawning seasons), utilization, fishery production, stock status, management, and rec-

ommended legislation/policies, along with bibliographic citations for 20 references. Similar information (i.e. listing of baitfish references, summarization in fisheries profiles) is available for the Solomon Islands, Palau (baitfish papers back to 1937), and Fiji. Two Pacific Island documents that would be extremely useful for baitfish research and management in Indonesia are:

- Dalzell, P. and A. D. Lewis (1989). A Review of the South Pacific Tuna Baitfisheries: Small Pelagic Fisheries Associated with Coral-Reefs. *Marine Fisheries Review*, 51 (4).
- Lewis, A.D., B.R. Smith, C.P. Ellway (1983). A Guide to Common Tuna Baitfishes of the South Pacific Commission Area. South Pacific Commission, Noumea.

Any substantive efforts on baitfish research and management, such as the WWF efforts in Larantuka and that proposed in the MSC-oriented fisheries improvement project, should include an element of assembling the results of past work. This could include on-line searches (most of the SPC baitfish documents are available through www.spc.int), cooperation with overseas institutions (CSIRO holds many papers put out by that and other institutions, including an Indonesian baitfish management plan), contacting individual researchers (many are still active or interested), and locating/summarizing past work by Indonesian researchers in both English and Bahasa Indonesia. The latter task may be appropriate for recently retired Indonesian fisheries researchers.

A close-up photograph of a fisherman's face, partially obscured by a large, colorful fishing net. The fisherman is wearing white-rimmed goggles and has a mustache. The net is made of red, blue, and yellow mesh and is filled with several large, silvery fish. The background is a blurred view of the water and some greenery.

7. Observations and Considerations on MSC Certification

This section is not intended to be a complete discussion of the relationship between Marine Stewardship Council certification and the management of Indonesia's bait-fisheries. The sections below are primarily intended to provide some MSC-related observations from the site visits and give some technical information for consideration by MSC specialists who may be unfamiliar with baitfisheries and their management.

A MSC-oriented fisheries improvement project (FIP) was prepared in late 2013 (Poseidon 2013). Earlier in that year an MSC pre-assessment was undertaken, followed by a scoping exercise. An FIP stakeholder workshop was held in Jakarta in December 2013. The individuals in charge of those exercises, and many IPNLF staff, have considerable experience in MSC matters, whereas the baitfish management specialist of the present survey has had only limited involvement with that certification system.¹

7.1 Observations from the Site Visits

At the three sites visited those stakeholders interviewed who were in a position to be knowledgeable about MSC (e.g. company managers) were asked about their views on MSC. The results are summarized in Table 4.

As expected, only a few people interviewed offered substantive comments on MSC. It is likely that the headquarters staff of the fishing companies visited would have more informed views.

7.2 What is Required for Baitfisheries by MSC

Currently there are a range of views on the MSC requirements for a baitfishery that supports a substantive fishery undergoing certification:

- Poseidon (2013) is an MSC-oriented fisheries improvement project. It states that “MSC requires that all product used for bait is an intricate part of the assessment, and therefore requires that the stock sustainability from the supplying fishery should also be assessed, irrespective of its location”. The plan proposed a fairly

¹ The terms of reference for the Baitfish Management Specialist do not mention MSC.

Table 4: Views on MSC

Location	Views on MSC
Larantuka	<ul style="list-style-type: none"> Fishing companies are aware of MSC. One company had a visit of someone from Europe looking at MSC issues (but did not investigate the baitfish situation). Another company has been wondering about the cost/benefit of MSC certification. That company cites the equal price paid for pole-and-line tuna and purse seine tuna, and wonders if certified fish will get the same price as uncertified fish.
Sorong	<ul style="list-style-type: none"> A representative of the largest local fishing company indicated that MSC needs to be discussed internally: “new to us and many things to learn”. With respect to MSC requirements, there are no indications of major baitfish resource problems, the major company has some monitoring records, the MPAs could be considered as being a management scheme, and there are conservation watch-dogs. On the other hand, improvements to baitfishing management associated with the Sorong-based pole-and-line fleet would involve working with more than one district.
Bitung	<ul style="list-style-type: none"> A fleet/cannery owner stated that MSC is a trend among retailers, but it is hard for Indonesia to comply. Currently, up-front costs are too high for his company. He thinks the pole-and-line association will move forward with MSC – but it is a long-term goal. He said he was more interested in obtaining market security than a price premium for MSC fish - some of his buyers indicate that MSC certification will be required in about 5 years. Staff of DKP Bitung City were unaware of MSC.

Source: Appendices 2 - 4

extensive array of activities for the baitfisheries, including application of SICA and/or PSA analysis², determination through Rapid Rural Appraisal of the susceptibility attributes for each site, training in risk assessment methods and the application of EAFM, a workshop to determine risk mitigation for retained and bait species, and collaboration with industry, universities, and various levels of government.

- A former MSC employee commented on the MSC baitfishery requirements at the IPNLF's Scientific and Technical Advisory Committee (STAC) in February 2014 by giving an example. He stated that for using squid from China in a Canadian fishery, there is no MSC requirement to study/manage squid in China (D.Leadbitter, per.com.).

² SICA = Scale Intensity Consequence Analysis, a qualitative analysis

PSA = Productivity-Susceptibility Analysis, a semi-quantitative analysis

- An enquiry was made to a current MSC employee during the present survey. His opinion on the MSC requirement for the baitfishery associated with the Indonesian pole-and-line fishery is that there needs to be some evidence that the baitfishery is managed (W.Holden, per.com.).

To add some context to the discussion of the MSC requirements for the baitfishing component, the assessment reports of three pole-and-line fisheries to have been certified were studied: (1) Tosakatsuo Skipjack Pole & Line Fishery, (2) Mexico Baja California Pole & Line Yellowfin & Skipjack Tuna Fishery, and (3) Pole-and-line Skipjack Fishery in the Maldives. The notable points of that examination appear in Appendix 6 below. In summary, there was almost no treatment of baitfish in (1), while in (2) and (3) the treatment of baitfish seems close to the Holden comment above: a demonstration that the baitfisheries are managed.

Given the range of views on the MSC requirement for baitfisheries, some clarification of the situation is required. Accordingly, the issue was discussed at the STAC meeting in February 2014. The report of that meeting gives high priority to IPNLF trustees obtaining definitive clarification from MSC (staff, technical advisors and board) of the requirements for a baitfishery associated with a fishery undergoing certification.

7.3 Additional Thoughts on MSC and Appropriate Indonesian Baitfishery Management

Without a definitive understanding of the MSC requirements for baitfisheries, a discussion of what is appropriate or inappropriate in Indonesia requires considerable speculation. Nevertheless, some comments can be made.

An appropriate management scheme for the baitfisheries in Indonesia does not necessarily equate to a scheme that is primarily oriented to meeting MSC standards. An appropriate scheme would probably have a wider range of management objectives than that presumably required by MSC. The additional Indonesian objectives are likely to include additional goals as the generation of government revenue and the reduction of baitfish wastage. It seems that an MSC-oriented management scheme would be unassailable in terms of meeting certification requirements, but Indonesian practicalities may receive less attention. Ignoring those

practicalities could doom the plan to being perpetually in the status of “still being implemented”.

One view is that, irrespective of precise MSC requirements, it is doubtful whether the Indonesian system can support such a massive upgrading of monitoring/research as proposed in the recent FIP - for a fishery that is relatively unimportant on the national scale. In this case, MSC compliance could be seen as a long-term goal, with some steps being taken to institute some management improvement as a start.

Alternatively, there is the view that what is proposed in the FIP is mostly sound, but needs to be adapted to the Indonesian context, mainly involving practicalities. This would involve features such as:

- Obtaining information on the condition of the baitfish stocks from historical research, and extrapolation from results from similar areas and the same species - with the idea that much of the information needed already exists. Over the long-term, developing of “rules of thumb” that relate sustainable baitfish yields to physical features of the baitfishing ground in question (e.g. area of shallow lagoon fringed with mangroves).³
- Predicating the management scheme on the district level (at least initially) and taking advantage of lessons learned from attempts at formulating FMA-level management plans.
- Relying on management controls that have a reasonable chance of working, rather than assuming that standard controls (e.g. spatial and seasonal closures) can be made to work.
- Adopting a more realistic time frame.

To a large degree, what is proposed for a management scheme in this report below follows the above adaptations.

³ For example, Dalzell and Lewis (1989) show that two baitfish grounds in PNG produced an average of about 1.06 tonnes of baitfish per sq km annually over an 11 year period. Similar information is available for Palau and the Solomon Islands. ACIAR has results of this type for Indonesia.

8. A Strategy for Producing a Management Plan



8.1 General Concepts

It is recommended that the production of a baitfishery management plan be based on several general concepts. Some of the concepts flow from above sections in this report. Some still need additional discussion (see workshop section below), while some were discussed with IPNLF management in Kuala Lumpur and were settled. The concepts that the IPNLF agreed to were:

- The scheme for producing a management plan will be based on two sites: Larak and the Raja Ampat area of Sorong.
- The general strategy would be to get management going at two locations where it is relatively easy to work and then, after it is up/running, expand the management to other areas.
- A fairly basic management framework is the most appropriate. This would consist of: (a) information on stock condition, (b) monitoring, and (c) an arrangement for applying controls on fishers should the monitoring indicate resource problems.

Some of the other concepts to guide the improvement of baitfishery management that flow from the present report are:

- A management plan for a baitfishery is not absolutely necessary, but in a developing country like Indonesia, a plan would be very helpful in facilitating management improvements.
- Management improvements promoted by IPNLF would need to be sensitive to the limited capabilities/interest at the district government level and compatible with the on-going NGO work.
- Considering the huge task of improving baitfishery management in Indonesia, work in cooperation with established NGOs is highly desirable, if not essential.
- Only those controls on fishers that have had some degree of success in Indonesia should be relied upon in the baitfish management scheme.

- Local baitfishery management plans prepared in the near future can be incorporated into FMA-type plans that may be prepared in the longer term.
- Wherever possible and appropriate, use should be made of previous applicable baitfish research.
- Simplicity is the key: the baitfishery management plan should be a short document that people and agencies will become familiar with and will keep and use.

8.2 The Management Framework

The management framework covers the objectives of the management, the main components of the management scheme, the management unit(s), and the form of the fisheries management plan.

8.2.1 Management Objectives

Indonesian baitfishery stakeholders have cited numerous possible objectives for baitfishery management. In addition, some of the major problems in a fishery can be converted into objectives (i.e. concern about baitfishing bycatch can be changed into the management objective of reduction of bycatch in baitfishing). There are also some objectives that are featured in many or most fishery management plans. Finally, there is the idea that at least some of the management objectives would be site-specific.

In the appendices on Larantuka, Sorong, and Bitung there are listings of “major concerns that management may be able to address”. Many of those concerns can be converted into objectives. The major ones cited were:

- The sustainability of the target baitfish resources
- Reduction of negative interactions with other groups of fishers
- Increasing the availability of baitfish through reduction of wastage
- Increasing the availability of baitfish through aquaculture

- Reduction of the negative impacts of destructive fishing on baitfish resources
- The generation of government revenue
- Reduction of the negative effects of near-shore FADs on certain species of bait
- Mitigation of variability in baitfish abundance
- Reduction in the catches of juvenile reef fish

As an appropriate mix of objectives (and a ranking of the objectives) is critically important for the success of the management scheme, additional site-specific discussion by stakeholders is warranted. Those discussions are also important for obtaining buy-in by those affected by the management scheme. Accordingly, it is proposed that a discussion of objectives be a major agenda item for the site Larantuka and Raja Ampat baitfishery workshops (see below).

8.2.2 The Main Components of the Management Scheme

It is recommended that the management scheme be minimalist and consist of just three components.

- Obtaining information on status of the baitfish resources: first by using the available information, then by extrapolating from studies on similar areas and the same species, then (if justified) new research. Establishment of “rules of thumb” (Section 7.3 above) should be done eventually and would simplify the assessing of resource status for other locations.
- Establishment of a monitoring system (or latching on to an existing system) that is oriented to learning of changes important to the management objectives (i.e. changes in baitfish CPUE, changes in baitfish mortality).
- Establish a system of controls (or latching on to an existing system) that would kick in when the monitoring detects problem. The MPA system is suggested, but there may be others that are effective in Indonesia.

Box 8: The Structure of the Maldives Live Bait Fishery Management Plan

Introduction

- Why a Fishery Management Plan?
- Some General Features of this Plan
- Some Definitions and Explanations

The Baitfishery in the Maldives

- General information
- Stock Condition and Structure
- Current Levels of Baitfish Exploitation
- Current Regulation of the Fishery

Current Management Issues and Difficulties in the Fishery

- Possibility of Over-Exploitation
- Attitudes of Fishers towards Management
- Interaction with Tourism
- Other Issues and Difficulties
- National Versus Atoll Regulation of the Fishery

The Objectives of the Management of the Fishery

- Objective #1: Protection of Baitfish Resources
- Objective #2: Raising the Awareness of Baitfishers of Management
- Objective #3: Reduction of Negative Baitfishery/Tourism Interactions
- Objective #4: Reduction of Baitfish Waste
- Objective #5: Reduction of Impacts on the Physical Environment
- Objective #6: Reduction of Impacts on Endangered or Protected Species

Summary of Management Interventions of the Plan

- Summary of Legal Interventions
- Summary of Interventions Dealing with Development and Awareness

Monitoring Associated with this Plan

Implementation and Adherence Considerations

Stakeholder Consultation and Modifying this Plan

Financial Considerations

References

8.2.3 The Management Unit

For reasons described in earlier sections of this report, it is proposed that the management scheme will be developed at two sites: Larantuka and the Raja Ampat area of Sorong. This follows from the strategy of initially working in one or two areas where there are favorable conditions. The good conditions at the two sites include the presence of NGOs, baitfish monitoring (Larantuka), effective management controls (Raja Ampat), willing pole-and-line companies, and milkfish culture close by. Overall, the desirability for starting at these two area is highly dependent on engineering cooperation from the NGOs in those areas (see below).

8.2.4 The Form of the Fisheries Management Plan

From Section 4.1 above, it can be seen that a fisheries management plan can take many forms. Based on experience in other developing countries in examining (a) baitfish management plans (global study; Gillett, 2012), (b) tuna management plans (12 Pacific Island countries; Gillett, 2009), and (c) shrimp management plans (global study; Gillett, 2008), some suggestions can be made. The study of tuna management plans (TMPs) is especially instructive – and the success factors are analyzed in Appendix 7. In short, experience over the past decade suggests the following are the most important in the success of a fishery management plan for tuna:

- Length/complexity of the plan document
- Presence of mechanisms to assure adherence to the plan
- How management and development are mixed in a single plan
- The type of external assistance used in plan formulation

Because the major success features above were incorporated into the Maldives Live Bait Fishery Management Plan (Gillett, Jauhareem and Adam, 2013), it is suggested that the Maldives plan be considered as a starting point for baitfishery management plans for Indonesia. The structure of the 13-page document is given in Box 8.

If the Maldives plan is to be considered a starting point, it would be important to discuss the appropriate modifications to that plan in the Larantuka and Raja Ampat workshops.

8.3 Steps in the Process: the way ahead

From the perspective of the baitfishery management specialist, a number of steps are required to progress from the present situation to having a functional baitfishery management plan. These steps are listed below. IPNLF staff and other stakeholders will probably want to modify the list and the required steps are likely to change depending on the discussions with the NGOs, companies, and government officials at various levels.

At this point the required steps appear to be:

1. Internal discussions within IPNLF that the concepts and management framework proposed in this report are appropriate and practical.
2. Integration (or reconciliation) of this report with what is planned for the associated pole-and-line fishery.
3. An approach by the IPNLF trustees to MSC to clarify the baitfish management requirements for a pole-and-line fishery undergoing MSC certification; modification of the management framework as necessary.
4. Estimation by IPNLF of budget requirements to carry these required steps; determination if that level of financing is likely to be available.
5. Engineering cooperation with the NGOs. This step is crucially important and may require several meetings and negotiations. Some of the considerations are:
 - a. A major incentive for WWF is that their baitfishery program in Larantuka is in need of a review (Section 3.1 above).
 - b. A major advantage is that the IPNLF Fishery Development Director has connections with the donors to those NGOs.

- c. TNC is not the only NGO active in marine work in Raja Ampat; discussions are also required with the other NGOs active in Raja Ampat.
 - d. Many of the following steps (and even choice of location) depend on the degree to which the NGOs cooperate.
6. Engineering cooperation with the major companies. Another critically important step.
- a. It is expected that the major companies are likely to be initially eager to cooperate on improving baitfishery management, but the critical aspect is the degree of cooperation when limitations on the fishery (e.g. limits to the total baitfish catch in an area) are being contemplated.
 - b. A major incentive for the companies is IPNLF could carry out demonstrations of improved baitfish handling, resulting in greater baitfish availability. Improving the fishing performance of the bait could be accomplished but that would require much more time and expertise.
 - c. In summary, discussions with the companies should emphasize long-term benefits of better management, indicating that they would be well worth the short-term pain.
7. Engineering cooperation with the various levels of national agencies
- a. Cooperation with the district DKP is very important, but the NGOs may have engineered much of this already. It should be noted that in most places the district DKP (a) has limited experience/interest in fisheries management, and (b) their main interest in fisheries is often government revenue generation and fisheries development. It therefore should be pointed out that the baitfishery management plan is likely to encompass both of those areas.
 - b. Discussions with the national government fisheries institutions should emphasized the national benefits of a successful approach to baitfishery management (i.e. ability to replicate). There should also be identification of national level specialists that could contribute to the project – and the terms under which that cooperation could occur.

8. Elucidation of historical information on baitfishery research in Indonesia
 - a. To avoid re-inventing the wheel” results of past baitfish work should be assembled. The various way that this could be done is described in Section 6.0 above.
 - b. Of special importance, the interest/availability of recently retired Indonesian fisheries researchers should be explored.
9. Production of paper/guidelines/notes of baitfishery management: what has been learned in the last 50 years in the world that is relevant to management of baitfishery in Indonesia.
 - a. It has been noted that the current cohort of fisheries specialists in Indonesia (many of whom are highly educated/motivated) lack historical knowledge of what has been learned in baitfishery research and the application of that to management of the fishery.
 - b. A sample of what could be expanded upon is given in the section above “Lesson Learned in Management Baitfisheries in Other Areas” (Section 5.2 above) – that could easily be expanded and made more useful.
10. Carry out further investigations on the legal basis of local fisheries management plans and their relationship to FMA-type fisheries management plans, bearing in mind the the various legal instruments (e.g. Ministerial Decree 29 of 2012) and precedents that have taken place in other fisheries in Indonesia.
11. Carry out the baitfish workshops in Larantuka and Raja Ampat (see next section)
12. Carry out initial field work in Larantuka. This may be modified, depending on the workshop and any work WWF may carried out themselves. A priority for IPNLF is to make sure the tasks given in Section 3.1 of this report are accomplished, preferably through IPNLF/WWF cooperation.
 - a. Determine the amount of bait in several randomly selected buckets during the bait loading process.
 - b. Take a video of the bait loading operation, from bagan net to pole-and-line vessel bait well. This would help determine the extent of baitfish handling problems.

- c. Make absolutely sure of the baitfish taxonomy. In baitfisheries in other countries incorrect baitfish identification has negated much of the value of years of sampling.
 - d. Conduct an external review of the baitfishery sampling strategy, information collection, and data analysis.
 - e. Collect information on baitfish mortality on the bagan and on the pole-and-line vessel
 - f. Get WWF staff familiar with the links between baitfish management objectives, required monitoring baitfisheries, and appropriate management action. Obtain knowledge of the results of previous baitfish research.
13. Initial field work in Sorong and Raja Ampat. This would focus on ascertaining the roles of the communities, the requirements for a baitfish monitoring programme, and how the MPA arrangements could act as a control on baitfishing.

Table 5: Some Thoughts on Task Allocation

Step	Who
1.	IPNLF trustees, Fishery Development Director
2.	Fishery Development Director
3.	IPNLF trustees
4.	IPNLF trustees, Fishery Development Director
5.	Fishery Development Director, Indonesia Country Representative; Some input from baitfishery management specialist may be helpful
6.	Fishery Development Director, Indonesia Country Representative
7.	Indonesia Country Representative
8.	Local consultant with baitfish experience
9.	Baitfishery management specialist
10.	Indonesia Country Representative and/or local legal consultant
11.	Indonesia Country Representative, Fishery Development Director, baitfishery management specialist
12.	Indonesia Country Representative, baitfishery management specialist
13.	Indonesia Country Representative, baitfishery management specialist

With a commitment from IPNLF, it does not seem unreasonable that most or all of the above tasks could be finished within six months, and certainly within 2014.

The above steps are foreseeable as being needed – and the results obtained dictate to a large degree what else should be done. At this point, it is difficult (or maybe even misleading) to speculate on future steps, except in very general terms. After the above is accomplished there is a need to initiate analysis of collected data, use all the assembled resource information (including that obtained by extrapolation) to make a preliminary assessment of the condition of baitfish stocks, identify any resource assessment gaps, formulate a preliminary baitfish management plan for each of the two locations, and discuss the plans with stakeholders.

It is assumed that IPNLF could make available for the above tasks the IPNLF Trustees (to a limited degree), the IPNLF Fishery Development Director, the IPNLF Indonesia Country Representative, various local consultants, and baitfishery management specialists. Some initial thoughts on who should do what are given in Table 5.



9. The Baitfish Management Workshops

Step #11 above involves baitfish workshops in Larantuka and Raja Ampat. It is believed that these two local workshops would be better than a national workshop because most of the issues that should be addressed are largely local in nature.

It appears that the main objectives of the workshops should be:

- Obtain a consensus by the major stakeholders of what the objectives of the management of the baitfisheries should be – and a prioritization of those objectives.
- Settle on the most appropriate control mechanisms: MPAs or otherwise.
- Promote stakeholder buy-in of the management process through their input at the workshops.
- Gauge the interest of the various participants of participating in the process, and partition responsibilities amongst those interested.

The topics to be discussed are problems and difficulties associated with the baitfisheries, what management can and cannot do about those difficulties, objectives of the management of the baitfisheries, management plans and how they assist in fisheries management, what type of plan would be appropriate, and the roles of the various stakeholders in the management process. Also to be discussed is IPNLF: its background, role in Indonesia, and the rationale for its involvement in Indonesian baitfisheries.

The participants should include IPNLF's Fishery Development Director and the Indonesia Country Representative, representatives of the NGOs working in the area, tuna fishing companies, bagan fishers, and communities. The latter is especially important in Raja Ampat where communities have had much interaction with baitfishers. Government agencies should be represented at both the district and national levels – and hopefully include individuals with resource, management, and enforcement backgrounds. It may be useful to have a baitfishery management specialist as a resource person. In terms of the numbers of participants, the ideal would be to have good representation from stakeholders, but not a meeting so large as to intimidate stakeholders who are uneasy in a meeting environment.

It is important to have the workshop at a location close to where the baitfishers operate to assure adequate participation. There are advantages of holding the workshop in Basaha Indonesia, with informal interpretation for those participants that do not speak Bahasa.



10. Concluding Remarks

The major recommendation arising from this survey is that IPNLF study closely the section “A Strategy for Producing a Management Plan” and endorse or modify the ideas put forward, including the general concepts, the management framework (objectives, components of the management scheme, the management unit, form of the management plan), and the future steps to be taken.

Other priority recommendations are:

- IPNLF trustees should obtain a definitive clarification from MSC (staff, technical advisors and board) of the requirements for a baitfishery associated with a pole-and-line fishery undergoing certification.
- At some point placing controls on baitfishing in Indonesia will probably be required (if not already) – for a variety of purposes. There is some indication that baitfish management being planned in Indonesia may be in danger of becoming reliant on controls that are non-functional. To overcome this fundamental problem, the use of MPAs has been promoted in the present survey, with the recognition that MPAs are a fairly blunt instrument for controlling fishing activities. It is therefore recommended that additional enquiries be made to identify other management controls that have enjoyed some degree of success in other Indonesian fisheries.
- The report discusses several ways that baitfish shortages can be mitigated (e.g. baitfish culture, alternative baitfishing methods, placing restrictions on the use of baitfish), but the pole-and-line fishing companies should not discount the value of increasing the tuna to baitfish ratio. In this respect, improving baitfish handling is the easy one – and should be promoted by IPNLF for its Indonesian members.
- Indonesian pole-and-line fishing companies that wish to be pro-active should institute their own baitfish monitoring programs – as that information is likely to be considered an essential component of a well-managed baitfishery, regardless of any MSC requirements.
- IPNLF should convince their members that, in the pole-and-line industry’s quest for sufficient baitfish, any initiatives that promote the concept that baitfish should receive preference over food for local consumption should be carefully

considered, as there is the possibility that it may tarnish some of the positive social credentials of pole-and-line fishing.

- Any substantive efforts on baitfish research and management, such as the WWF efforts in Larantuka and that proposed in the recent MSC-oriented fisheries improvement project, should include an element of assembling the results of past baitfish work.

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Appendix 1: People Consulted

Jakarta

Ministry of Marine Affairs and Fisheries

Advisor to the Director-General

- Agus Budiman

Directorate of Fish Resources

- Toni Ruchimat
- Jimmi
- Saut Tampubolon
- Erni Widjajanti

Directorate of Fishing Vessels and Gear

- Imron Rosyidi
- Bagus Oktorisutrisno
- Linga Parrotarigum

Sub-Directory of Capacity Building

- Kusdiantoro

PT Ocean Mitramas in Jakarta

- Yanti Djuari
- Vito
- Vicky
- Bambang
- Hamonangan

WWF

- Abdullah Habibi

P4KSI

- Agustinas Nanung Widodo

NTT

PT Ocean Mitramas

- Ferry
- Rastum

PT Primo Indo Ikan

- Andayani

PT Okishin

- Alum Sitabutar
- Hilmar Dayton

Bagan captains

- Mikson Huky
- Varif
- Taslim

Bagan Owner

- Bento

DKP NTT Province

- Aba Maulaka
- Baneef
- Stefani Boro
- Kletus Tese

DKP Kupang District

- Ahmad Yani

DKP East Flores District

- Daimikhus

The Nature Conservancy

- Yusuf Fajariyanto

WWF

- Toufik Alansar
- Saraswati Adityanini
- Subang Roga (Larantuka sampler)
- Amid (Larantuka sampler)
- Hickson (Larantuka sampler)

Fishing and Living (Anova Field Office)

- Milkyades

Sorong

PT Citraraja Ampat

- Diane Sumendap
- Suyoto

PT Perikanan Nusantara

- Akmad Sholihin
- Hamione

PT Radios Apirja Sorong

- Yanti
- Maxi

DKP Sorong City

- Ruddy Laku

Bagan operators

- Palamodar
- Laratu

Pole-and-line operator

- Marten Bawo

The Nature Conservancy Raja Ampat Office

- Purwanto

Bitung

Wageningen University

- Simon Bush
- Megan Bailey

Fishing and Living

- Momo Kochen

DKP Bitung City

- Deddy Mondak
- Ellen Mamahit

PT Samudra Mandiri Sentosa

- Abrizal Ang

PT Bintang Mandiri Bersaudara

- Junaiddi Tjung
- Keegan Kojoh
- Roy Rumababa

National Fishing Boat Association (AKPN)

- Noldy Lamalo
- Decky Sompotan
- Jeffery

Bagan owners

- Faisal Wengke
- Abdulin

Beach seine owners

Mangantara Alia

Akson

Berti

Others

Tony Lewis, Consultant

Bill Holden, Marine Stewardship Council

David Itano, US National Marine Fisheries
Service

Appendix 2: The Baitfishery of Larantuka

Information on live-bait pole-and-line tuna fishing in the area

- Pet and Mous (2012) state “the total number of pole-and-liners landing in Larantuka is 125 boats and annual landings amount to 250 tons per day. Because of seasonal bait shortages and because of shortage in the week around full moon, a pole-and-liner is only operational for about 50% of the year. Pole-and-liners may switch to fishing for large tuna using hook-and-line if large tuna is plentiful or if bait from the local bagan (light attraction) fishery is unavailable.
- The official fisheries statistics of East Flores state that in East Flores there were 60 pole-and-line boats in 2012.
- In 2012 24 pole/line vessels were given by government to fishing groups in NTT, presumably many went to East Flores.
- The staff of three Larantuka-based fishing companies indicate that:
 - From 80 to 100 pole-and-line boats are based in Larantuka, but not all are operational at any given time (perhaps only 60%)
 - Four large companies have fish buying arrangements with the vessels, which are owned by mainly local individuals
 - The fleet has grown in the past 5 years, much of which is due to government-granted vessels
 - The vessels use ice for catch preservation and have natural water circulation in the bait tank.
 - The vessels are divided into two size classes: less than 30 GT, greater than 30 GT
 - The low season (Jan-Mar) is because of rough seas - for both tuna and for bait fishing
 - Some vessel switch to handline gear when baitfish is unavailable
- The stated annual production of tuna by the pole-and-line vessels associated with the three fishing companies interviewed seemed surprisingly small. For example, the 30 boats of Mitramas producing 1,400 mt in 2013 (i.e. 47 mt per boat per year) is tiny. This was explained to be an artefact of the loose arrangement between the companies and vessels in which vessels occasionally sell to other buyers. This complicates the estimation of baitfish requirements for the entire Larantuka-based fleet.

Baitfish requirements

- The staff of three Larantuka-based fishing companies indicate that the pole-and-line vessels require from 3 to 5 buckets of bait per day for the small (<30 GT) boats and about 7 buckets for the larger (>30 GT) ones.
- Discussions suggest that a bucket contains about 20 kg of bait (but there is some uncertainty in this figure). Itano (1993) gives 7 kg per bucket.
- For the baitfish-tuna ratio, one company suggests 1:11 (based on 7 buckets a day usage for 1.5 mt average daily tuna catch), while another company thinks that the ratio is 1:20 (based on fishing knowledge).
- An annual 15,000 mt pole-and-line fishery which has a 1:15 baitfish-tuna ratio, requires 1,000 mt of bait.

The scope of the baitfishery(ies) in the area; the unit of coverage

- The bagans are clustered around 5 areas in the Larantuka area and one in Lembata, with the closest other area of concentration being in east Sumbawa - but those produce exclusively for consumption.

The various baitfishing operations: types of operations, size of operations and techniques

- The consensus of opinion from 3 bagan fishing captains (collective bagan experience in Larantuka spanning 55 years) indicates:
 - Most of the bagans in the Larantuka area are about 15 to 19 meters in length and 15 to 19 meters in width, with much larger bagans in Kupang (38 x 40 m). The Larantuka bagans were constructed of wood in Bima.
 - A crew of 5 to 7 men is used, with the owner not typically part of the crew.
 - About 20 to 25 lights are used from 5 places on the bagan, with most on the bow. They are powered by a 3 kw generator.
 - The net (3 mm mesh) is typically pulled twice during a fishing night.
 - The water depth is typically 11 to 80 meters, and the fishing depth of the net is 5 to 7 meters.
- Lampara gear operated by non-bagan fishers produces some bait (perhaps 10% of the total), but results in higher mortality. Lampara gear is useful for catching bait for handlining. Boke Ami gear is not used in the area.

The major baitfish species

- The major baitfish species are:
 - **Tembang:** sardinella; A very common baitfish, about 70% of catches; presumably *Sardinella fimbriata*
 - **Rambeng** (small size), **pisang-pisang** (large): the fusilier *Pterocaesio pisang*. This and tembang are the most common Larantuka baitfish.
 - **Layang:** decapтерus; the third most common species. Itano (1993) gives 3 decapтерus species, but fishers only recognize one.
 - **Teri:** anchovy; fishers recognize three species: the white (fishers say this species quite weak), black, and red. One sample of the white was observed: *Encrasicholina heteroloba* – this has major implications for baitfish management (i.e. improved handling could remarkably decrease *E. heteroloba* mortality). The red anchovy could be the weaker *Encrasicholina devisi* (which is very similar to *E. heteroloba*) due to its reddish color under lights at night. This identification is supported by Itano (1993) who indicated that in the Sorong area, the red anchovy is *E. devisi*. The black anchovy is described by Larantuka fishers as being very strong, and some say it only appears occasionally, so it is likely to be *E. punctifer*, a contention that is reinforced by one fisher stating he saw the fish in the open ocean.

Cost of baitfish

- The consensus of opinion from 3 bagan fishing captains indicates an average price of IDR 250,000 to 300,000 per bucket, with the higher price being received now due to the poor fishing season (January). They sell layang for somewhat higher price for food.
- The fishing companies indicate some species consideration in pricing, with the tembang (sardinella) being the cheapest, followed by layang, and the “black anchovy” being the highest price (sometimes up to IDR one million per bucket). With the exception of layang, the fish sold as food appear to receive a lower price than that for bait.

Baitfish handling and wastage

- The fishing companies indicate baitfish mortality (which presumably spans the period from bagan transfer to broadcasting) as being 70% for tembang (which has the highest mortality) to 5% for the “black anchovy” (which has the lowest). Bait is only carried for one day maximum (up to 20 hours), after which it is sold for food.
- The 3 bagan fishing captains indicate baitfish mortality (which presumably spans the period from pulling the net to pole-and-line transfer) as being about 20 to 30%, with that of the “white anchovy” being the highest.
- When catches consists of a high proportion of “white anchovy” the pole-and-line fishing grounds must be close by.
- Some other baitfish handling considerations are: (1) Baitfish handling in recent years is rougher due to competition among pole-and-line vessels for limited bait supplies (i.e. faster loading), and (2) Captains/ companies are interested in training on improved baitfishing handling techniques.
- The WWF enumerators indicate that bait is dry-scooped in the transfer process.

Who controls the baitfishing operations?

- Most of the bagans are owned by local residents. Typically, the owner has a single bagan and does not work on the vessel but hires crew to do so.
- According to three bagan captains, all operational fishing decisions (e.g. where to fish, when to fish) are made by the captains.
- PT Ocean Mitramas owns three bagans.
- There is no association or informal grouping that represents the interests of bagan fishers.

Numbers of units; production

- The official fisheries statistics of East Flores District show that in East Flores there were 61 movable bagans in 2012, down from 108 in 2006. Zero fixed bagans were recorded in both 2012 and 2006. The official fisheries statistics of NTT Province show 114 movable and 57 fixed bagans in 2012 in East Flores District. NNT DKP officials state that in 2014 in all of NNT province there are about 60 movable bagans.

- The consensus of opinion from 3 bagan fishing captains indicate 39 bagans (all moving bagans) operate in 5 locations around Larantuka - plus 16 on the nearby island of Lembata. All of those bagans sell at least part of the catch for pole-and-line bait. The good baiting season is from April to May, with the bad season from January to March (too much wind). Catches now range from zero to 50 buckets, with the average being 8 buckets. The captains report to the bagan owners the total catch per night (not broken down by species) and total revenue for the night.
- The catch of most bagans is partitioned between baitfish and food, with the proportion depending on the various operations, prices, and species. Often prices are higher for baitfish, except for the weak species.
- Since May 2013 WWF has been monitoring total catch by bagans by night and species composition.

The recent trends in the baitfishery, including trends in catches

- Official East Flores District Fisheries statistics show a 43% reduction in the number of bagans during the 2006/2012 period. However, the three bagans owners say the number of bagans in the general Larantuka area have definitely increased in the last decade; from about 20 ten years ago to 39 today.
- Although the three bagan captains report total catches and revenue on a daily basis to the owners, they are unsure if that information is retained. One bagan owner says his records are available for the last six years.
- The three bagan captains recall catches earlier in their careers that ranged from zero to 100 buckets, whereas in recent years the range has been zero to 50.
- A general decline in CPUE is recognized by bagan fishing captains, pole-and-line fishing companies, and the one bagan owner interviewed. Catch rate drops are especially pronounced with the “black anchovy” and the rambeng (fusilier).
- Both bagan fishing captains and pole-and-line fishing companies stated a near absence of the “black anchovy” since 2000.
- The pole-and-line fleet growth has created more demand for baitfish. There is also increasing demand for baitfish as food, plus the additional demand created by a new fish meal plant in the district.
- In about 2005 electrical generators replaced petrol-powered lanterns.

What are the major concerns that management may be able to address?

- The drop in CPUE of baitfish since 2000.
- The almost complete absence of the “black anchovy” since 2000.
- Competition between pole-and-line vessels for limited bait supplies.
- Negative interactions with lampara and purse seine fishers: competing for the resource and conflict on fishing grounds; Conflict with pearl farmers.
- The increasing prevalence of dynamite fishing and the use of cyanide by other groups of fishers.
- Although not mentioned in interviews, there is very high mortality of baitfish; wastage of bait could be addressed by management.

Current management of the baitfishery

- When questioned on current management, most stakeholders indicated that no management or rules are applied to the fishery – but on probing, they recognize that licensing could be considered a form of management.
- Of the three bagan captains interviewed, none were operating a licensed vessel, saying that their licenses were “being processed”.
- Although the national-level Ministerial Decree No.18 of 2013 has provisions for bagans (mesh sizes, light power) companies and vessel operators interviewed were unaware of the decree. The DKP at the provincial and district levels seemed vaguely aware of the decree. It should be noted that the mesh/light requirements of the decree place little restriction on the fishery (i.e. allowable mesh size is very small, allowable light power is relatively large).
- Bagan fishers and companies have the notion that should a bagan from outside the district arrive for fishing in the Larantuka area, its newly granted license will have geographic restrictions.
- The head of the DKP Flores District indicates there is no such geographical restrictions, but management interventions consist of:

- The requirement for a bagan to have a license and the ability of the District government to refuse a license should conditions warrant (upon questioning: no license yet to be refused). They would use information from a past university study to make such a decision (but apparently the study does not cover specifically the area in question or the important baitfish species). They would welcome additional resource information from WWF.
- The informal use of a “national government decree on non-selective fishing gear”
- The informal use of “local wisdom” such as not disturbing other bagans by fishing too close, prohibition on fishing on certain days and in certain areas (mainly due to religious reasons)
- The government adding 3 bagans to the fleet – to help mitigate baitfish shortages for the pole-and-line fleet

The main institutional and procedural difficulties in the management of the baitfishery

- There is little heritage of successful fisheries management in the area. The district has the authority for management of the fisheries in the area where bagans operate, but at that level of government there are little experience and skills in management.
- Improving the management of the bagan fishery would be a very large task in the district, but bagan fishing is relatively unimportant in the area.

Aquaculture considerations

- There is certainly interest in using milkfish as bait, but the tuna fishers are unconvinced of how good the bait is (i.e. baitfish-tuna ratio).
- The selling price of milkfish by the PT Mitramas operation in Larantuka (IDR 500,000 per bucket according to the farm manager) compares favorably with wild bait during times of bait scarcity, but it is uncertain that this price is what the price will actually be and uncertain that interested pole-and-line vessels will actually pay that amount.
- A Jakarta-based PT Mitras manager said the operations would be viable except for the necessity to charter a plane to get fry from Bali: “Viable for part of our baitfish requirements if we can produce fry in Larantuka”.
- There is some question of what to do with milkfish that reach harvestable size during the January-March period when there is little pole-and-line fishing.

MSC considerations

- Fishing companies are aware of MSC. One company had a visit of someone looking at MSC issues (but did not investigate the baitfish situation). Another company has been wondering of the cost/benefit of MSC certification. That company cites the equal price paid for pole-and-line tuna and purse seine tuna, and wonders if certified fish will get the same price as certified fish.

Main informants:

- Staff of three fishing companies, three bagan captains, one bagan owner, head of DKP East Flores, four WWF staff

Appendix 3: The Baitfishery of Sorong

Information on live-bait pole-and-line tuna fishing in the area

- Itano (1993) wrote that two decades ago PT Usaha Mina owned 20 pole-and-line boats while 34 privately owned vessels unloaded at the base. [That company ceased to exist about 10 years ago.]
- PT Citraraja currently is associated with 30 pole-and-line vessels, of which about 25 are active. The vessels have both natural and pumped circulation in the bait wells. Those vessels offload and supply in Sorong, but obtain bait daily from locations near Waigeo and Misool islands in the Raja Ampat area. The vessels are mainly 50 to 60 GT and the average daily catch, according to the fishing operations manager, is about 3 mt. Average annual production of tuna from the company's boats was stated to be 3,000 to 4,000 mt in recent years.
- PT Radios Apirja Sorong is associated with 4 pole-and-line vessels that fish the Fakfak area and deliver tuna to the Radios base in Sorong. One company captain interviewed indicated his vessel was 87 GT and has both natural and pumped circulation in the bait wells. The company prefers the pole-and-line fishing in the Fakfak area because there is too much interference from tuna purse seining in the fishing grounds closer to Raja Ampat. Company staff report that annual pole-and-line catches in recent years have been about 1,000 mt.
- PT Perikanan Nusantara collects tuna from one pole-and-line vessel (60 GT) that fishes out of the Fakfak area. They report weekly tuna catches of 10 to 14 mt.
- The information obtained from the above three companies indicates:
 - Currently 31 active pole-and-line vessel are associated with companies that operate out of Sorong
 - Operations of the above companies (baitfishing, tuna fishing, tuna landing) occur in 3 districts of West Papua Province
 - Information on annual fleet landings appears inaccurate/incongruous, probably due to its confidential/sensitive nature.

Baitfish requirements

- The fishing operations manager of PT Citraraja indicated that his boats take on 90 to 100 buckets of bait. He stated that a bucket contained about 10 kg of bait (but later in the interview, revised that amount to 5 kg). On the average that bait results in about 3 mt of fish, or a bait to tuna ratio of 1:6 – but the manner in which this was stated (and the poor ratio) indicate that the manager was not used to thinking in terms of ratios or kgs.
- The captain of a pole-and-line vessel associated with PT Radios stated that his vessel (87 GT; somewhat larger than those of the Citraraja fleet above) takes on an average of 120 buckets of bait for a fishing day.
- With respect to bucket size:
 - The buckets observed in a 15 minute PT Citraraja baitfishing video appeared to contain about 5 to 6 kg of bait.
 - A pole-and-line captain indicated that a bucket contains from 5 to 10 kg of baitfish
 - Itano (1993) commented on the bucket size in the Sorong baitfishery: “Most estimates of the amount of baitfish contained in an Indonesian “bucket” range from 6 to 7 kg of bait after the water has been drained away and the fish are weighted without drying. I carefully weighed a bucket of bait during bait loading operations in Labuha which weighed 8.22 kg.”

The scope of the baitfishery(ies) in the area; the unit of coverage

- Itano (1993) stated that the main baitgrounds are Aljui Bay in Waigeo and Gam Island. Other important baitgrounds are at Batanta (Nanas, Amdui, Teluk Gergaji, Hal Besar and Dayang), Kofiau Island, Teluk Sebakor (S. of Fak Fak) and several bays in the south between the coastal towns of Kanoka and Madowi on the Irian Jaya mainland.
- According to the fishing operations manager of PT Citraraja, the baiting grounds utilized by bagans they are associated with are all located at Waigeo and Misool islands, about 12 hours travel by pole-and-line boat from the base in Sorong. Those grounds are in a different district (Raja Ampat) from that of Sorong.
- PT Perikanan Nusantara is associated with a pole-and-line vessel that obtains bait from the Fakfak District located on the Papua mainland southeast of Sorong and Waigeo/Misool.
- PT Radios obtains bait from the Fakfak area.
- About 10 bagans operate in the vicinity of Sorong City – but these produce exclusively for consumption.
- From the above, it appears that for pole-and-line baitfish purposes, there are 3 general baitfishing areas located in two different districts, which are different from the Sorong City district where most pole-and-line vessels are based.

The various baitfishing operations: types of operations, size of operations and techniques

- The largest Sorong fishing company indicates that all of their bait comes from bagans, with none from lampara, beach seine, or boke ami gear. The bagans measure on the average 17 m x 17 m, but some are as large as 20 m x 20 m. They are all owned by individual owners, who are typically of south Sulawesi origin. During baitfishing about 20 lights (18 to 23 watt) are used from the bow of the vessel, plus a 500 watt underwater bulb. The bagans fish each night of the month, except 3 days around the full moon and occasionally when there is a need to service the vessels.
- PT Radios has 5 company-owned bagans in the FakFak area, plus obtains bait from a few non-company bagans in that area.
- PT Perikanan Nusantara buys bait from a few bagans in the Fakfak area.
- Baitfishing bagans are all of the moveable type because they fish in about 50 metres of water, too deep for a fixed bagan.
- The bagans that fish in Raja Ampat remain at particular location for about two weeks, but because catches tend to drop off after such a time (i.e. local depletion), they usually move to a new location. A bagan captain stated that it takes about 10 days for a depleted area to recover.

The major baitfish species

- According to the fishing operations manager of PT Citraraja (which obtains bait in the Raja Ampat area), the major baitfish species are three types of anchovy (white, black, red), a sardine, and layang. The black anchovy is considered the best because of its survival after capture and action in the water.
- A bagan owner and a pole-and-line fishing captain associated with PT Citraraja, recognize three species of anchovy: black, red, coral. The latter has the Indonesia name of “puri kasan” and the local name of “maeroa”, which is apparently not an anchovy but a sprat (probably *Spratelloides gracilis*). Other important baitfish are layang (*decapterus* sp.) and tembang (*Sardinella fimbriata*). The black anchovy (*Encrasicholina punctifer*) accounts for 75% of the baitfish catch.
- Fishers associated with PT Radios (which obtains bait in the Fakfak area) say that small layang is the most prevalent baitfish at certain times of the year. It is not considered an especially good bait – and sometimes when catches are exclusively small layang, the pole-and-line vessels will not attempt to fish with that bait.

Cost of baitfish

- According to the fishing operations manager of PT Citraraja, all bait is purchased at IDR 13,000 per bucket, with the price being the same for all species. This price is the “operation price”, as some of the tuna catch is also exchanged for baitfish.
- A PT Perikanan Nusantara associated bagan indicates that they sell bait in the Fakfak area for IDR 25,000 per bucket.
- PT radios says they purchase bait in the Fakfak area for IDR 15,000 per bucket
- DKP indicates catches from bagans close to Sorong are sold as food for IDR 170,000 to 180,000 per basket (uncertain weight). Baskets observed at the Sorong fish market appeared to hold 20 to 30 kgs of baitfish.

Baitfish handling and wastage

- According to the fishing operations manager of PT Citraraja, baitfish is transferred to the pole-and-line vessel in a bucket that averages half water and half baitfish. The mortality from transfer from bagan to broadcast averages 25%, with the black anchovy about 20% and the other species about 30%. Onboard the pole-and-line vessel, the dead baitfish are netted from the bottom of the bait tanks. The manager says that he has been working to improve baitfish handling (he remembers the visit of D.Itano 20 years earlier) and would appreciate additional suggestions.
- A captain and a bagan owner associated with PT Citraraja indicate that onboard bagan baitfish mortality averages 10% and onboard pole-and-line vessel mortality averages 10% - both of which are affected by conditions during bagan fishing (i.e. rough vs calm), the species of baitfish, and the density of baitfish in the bait tanks.
- The fact that Citraraja/Radios have 50% milkfish mortality with milkfish suggests that their handling techniques are fairly brutal.
- A 15 minute PT Citraraja video of their baitfishing shows that for the transfer bagan-vessel, bait is semi dry-scooped (i.e. as the scoop net is raised out of the bagan net, some baitfish remain underwater, some are raised out of the water) into a bucket half full of water and then passed to the bait well. Upon questioning, this transfer technique was confirmed by a pole-and-line captain and a bagan owner.

Who controls the baitfishing operations?

- PT Citraraja states that they communicate with the bagans so that they are located close to the general pole-and-line fishing area, but the precise spot for baitfishing is selected by the crew of the bagan. The company sometimes speaks to the bagans by mobile phone three times per day.
- Bagans that operate in area close to Sorong have a grouping that is primarily concerned with fish selling prices. Apparently, such groupings do not exist for bagans that fish in the Raja Ampat and Fakfak areas – but the need for a grouping in the Fakfak area is recognized by PT Perikanan Nusantara.

Numbers of units; annual production

- Fishing companies provided information on the number of bagans:
 - PT Citraraja indicates that 29 bagans provide bait to their fleet, with an additional 5 or 6 bagans fishing only for food (all in Raja Ampat area). Four of those baitfish bagans are at Waigeo and 25 at Misool.
 - PT Perikanan Nusantara's vessels obtain bait from the fleet of 5 bagans operating in the Fakfak area, where their one associated pole-and-line vessel is based.
 - PT Radios owns 5 bagans in the Fakfak area, plus they obtain bait from a few non-company bagans in that area.
 - It can be concluded from the above that in the Raja Ampat and Fakfak baiting areas there are about 39 bagans that provide bait to pole-and-line boats.
- The poor fishing season in the Raja Ampat area is June-August (too much wind) and in the Fakfak area from February-April (prevalence of small layang, a poor bait). The Fakfak bagans do not wish to move seasonally to Raja Ampat because their associated pole-and-line vessels do not like to tuna fish that area due to the negative interactions with pole-and-line vessels.
- About 10 bagans are based close to Sorong City, but produce fish exclusively for consumption. Those bagans sometimes move to Waigeo/Misool during good fishing in those areas.
- PT Citraraja states that layang and the sardine (about 20-30% of total baitfish production) is mostly sold as food or bartered for cigarettes. Because anchovies are not very popular for food, almost all of those fish are sold as bait. The bagans in the area immediately around Sorong (about 10) produce exclusively for consumption – with the whole Sorong bagan fleet producing about 3 mt per day during the high season.
- An aerial survey by TNC of the bagans in Raja Ampat shows about 30 bagans in January 2006. This is very close to the number in 2014. The TNC survey showed a seasonal variation (i.e. 55 bagans in September 2006).
- Bailey et al. (2007) is a study of the bagan anchovy fishery of Kabui Bay in Raja Ampat. Annual per bagan catch varied from 49 to 76 tonnes, with a mean of 62 tonnes. Annual catch for the entire fleet (50–60 boats) ranged from 2493 to 4468 tonnes, with a mean of 3389 tonnes.

The recent trends in the baitfishery, including trends in catches

- PT Citraraja indicates that they keep records of the amount of bait purchased from each bagan each day in kgs and money – but no species information is collected.
- PT Citraraja, which obtains bait in Raja Ampat, states that no drop in CPUE has been noticed in the last decade – with the only noticeable trends are the increasing amount of baitfishing area being dedicated to marine protected areas (which tends to reduce total catch), and (b) the increasing proportion of baitfish being used as food.
- The two companies that operate in the Fakfak area indicate no long-term trends in CPUE are discernable.
- Using fisher interview data collected in the Raja Ampat archipelago, Ainsworth et al. (2008) suggest a decline in the relative abundance of anchovy during the period 1980 to present. [the methodology needs to be scrutinized]
- Petrol lamps on bagans were replaced by electrical bulbs about 10 years ago and underwater lamps were added about six years ago.
- With the decline of pole-and-line fishing in the Raja Ampat and Fakfak areas, there has been a decline in the amount of baitfish required by the fleet since the days of PT Usaha Mina.

What are the major issues and the major concerns that management should address?

- Itano (1993) stated “The Sorong base is blessed with productive baitgrounds near all fishing grounds and bait supply is seldom a problem. Bait is usually not available during full moon periods but this time is considered important for vessel maintenance and to give the crews and fish stocks a break.”

- According to the fishing operations manager of PT Citraraja, there has been no decline in baitfish CPUE in the last decade and no bagan-related conflicts – but some competition between pole-and-line vessels to obtain baitfish supplies.
- DKP Sorong City indicates that the main problems with the bagans are (1) the situation where a licensed bagan is approached by residents adjacent to baitfish grounds for additional payment – which is considered double payment by the bagan operators, (2) the declining baitfishing area due to the expanding of areas dedicated to MPAs.
- PT Radios indicates that the baitfishing-associated fees they must pay in the Fakfak area are painful: payments to the village for bagan fishing and for the associated pole-and-line vessel, and payments to the governments of the sub-district and district.
- A PT Perikanan Nusantara associated bagan indicates their main difficulties are not having an association to represent them and the need too constantly move around to follow the pole-and-line fleet.
- Overall, the fishing companies and pole-and-line operators are fixated on the pole-and-line fishing problems caused by interactions with tuna purse seiners, rather than on baitfish resource difficulties. The major baitfishing problems are associated with creeping fee demands and (for Raja Ampat) creeping MPA areas.

Current management of the baitfishery

- The current management of the baitfishery appears to be limited to the requirement for a license and the prohibition on fishing in MPAs. Less formally, there is the understanding that fees must be paid to communities adjacent to baiting grounds.
- According to DKP Sorong City, the bagans that move from Raja Ampat to fish in the area close to Sorong City do not need a license, but only need to inform village authorities. He stated that MPAs have been established by WWF, TNC, and/or CI – in cooperation with the local government – and, although they have had a positive effect on tourism and the environment, they have decreased the total baitfish catch in the Raja Ampat area.
- The Nature Conservancy (TNC) has a different perspective on the MPAs. According to TNC's Bird Head MPA Technical Advisor, six MPAs have been established in the Raja Ampat area with the support of TNC. Stakeholder consultation was an important part of that process, but as bagan operators are considered "outsiders" they were not consulted. Although baitfish resource conservation was not a major consideration in establishing the MPAs, the Advisor feels that MPAs could help with baitfish overfishing – a condition that was determined from community consultations.
- According to PT Citraraja, about 3 or 4 of the bagans sometimes fish inside the MPA – despite the local MPA patrols. A bagan captain that was caught fishing inside the MPA a few times said that he was just told to go away, with no punishment.
- The management of marine activities in the Raja Ampat area appears limited to MPAs, whose establishment is encouraged by NGOs. The MPAs with their zonation and bans on fishing (including bagan fishing) near resorts, could be considered as a form of management intervention whose objective is separating fishing activities from resort areas.
- Subsidies could be considered a form of management intervention. According to the fishing operations manager of PT Citraraja, "working capital" is provided by DKP to some bagan operators. A pole-and-line captain and a bagan owner stated that they had no knowledge of such subsidy.

The main institutional and procedural difficulties in the management of the baitfishery

- Fishing companies, pole-and-line operators, and bagan captains, feel that government agencies, (including the DKP) have had little interaction with baitfishing
- Discussions with the staff of one NGO suggests they are not very focused on bagan fishing or resources targeted by bagans.
- The district level has much of the authority for management of the fisheries in the area where bagans operate, but at that level of government there are little experience and skills in management.
- In the Raja Ampat area, tourism-oriented objectives appear much more important than objectives associated with bait fishing.
- Improvements to baitfishing management associated with the Sorong-based pole-and-line fleet would involve working with more than one district.

Aquaculture considerations

- Although baitfish is plentiful in the area, the interest in milkfish stems from (a) the poor bait catches around the full moon and during rough weather and (b) the reduced amount of baitfishing area to the expanding numbers of MPAs.
- PT Citraraja has carried out cultured milkfish trials in cooperation with a local fisheries academy, using fry purchased in Makasar (IDR 30 per fingerling). The two trials suffered high mortality (about 50%).
- PT Radios has trialled the culture and use of milkfish as bait with one pilot pond near the company base. Staff of the company state they purchased fry at IDR 65 apiece and the cost of raising them to baitfish size is IDR 250 apiece. The company is still considering the results.
- There is milkfish culture operation being developed near Sorong City for primarily for food for consumption. The ponds are still under construction – and they may total 100 hectares in the future.

MSC considerations

- A representative of PT Citraraja indicated that MSC needs to be discussed internally: “new to us and many things to learn”.
- There are no indication of major resource problems, the major company has some monitoring records, the MPAs could be considered as having some management scheme, and there are conservation watch-dogs. On the other hand, improvements to baitfishing management associated with the Sorong-based pole-and-line fleet would involve working with more than one district.

Main informants:

- PT Citraraja, PT Perikanan Nusantara, PT Radios, DKP Sorong City, bagan operators, pole-and-line operators, and TNC.

Appendix 4: The Baitfishery of Bitung

Information on live-bait pole-and-line tuna fishing in the area

- Itano (1993) states: “The North Sulawesi Provincial Fisheries Office in Manado listed 142 licensed pole-and-line boats in North Sulawesi, but they estimated that only 40% (n=57) of those listed were still operational. A representative of a Bitung cannery independently estimated the number of active pole-and-line boats in the Bitung area at 50-60. At the same time, a vessel owner in Bitung estimated the actual number of fully active Bitung boats at a maximum of 30. The size of the vessels are mostly over 40 GT ranging up to 100 GT.”
- The Annual Report DKP Bitung City 2011 states there are 8 pole-and-line vessels 10 to 30 GT and up to 30 vessels over 30 GT.
- Leadbitter (2012) states that PT BMB in Bitung has 5 pole-and-line vessels out of an estimated 40 in the port.
- Staff of PT Bintang Mandiri Bersaudara state there are 4 fishing companies in Bitung with pole-and-line vessels and two vessels that are individually owned. The total number of pole-and-line vessels based in Bitung is about 50 (40 to 80 GT), with estimates of between 10 and 40% of those vessel being non-operational. Also in North Sulawesi Province, 2 or 3 vessels are based in Labuan and about 20 vessels in Gorontalo. Pole-and-line vessels are also based in neighboring provinces: Bacan (about 20 to 30 vessels) and Kendari (somewhat less than the number in Bitung).
- The above vessels do not include the small outboard-power “funai” pole-and-line vessels which, in North Sulawesi Province, are found close to Manado (perhaps 100 are located there) and to the north and south of Bitung – and fish for local consumption.
- The pole-and-line vessels based in Bitung are typically 40 to 90 GT, have pumps for bait tank circulation, carry ice, and do 1 to 3 day fishing trips. The good skipjack fishing season is from September to December.
- A fleet owner indicated that fuel for pole-and-line vessel is subsidized at about 40 to 50%.
- A cannery owner indicated that the market for his pole-and-line fish is in the EU, USA, and the Middle East. He receives about 10% more for his pole-and-line fish than for his purse seine fish.

Baitfish requirements

- An operator of an 85 GT pole-and-line vessels indicates he loads 150 to 200 buckets for a fishing trip. A fleet manager whose vessels are somewhat smaller indicates his vessels take on about 100 buckets for a trip.
- Estimates of the amount of bait contained in a bucket by captains/managers interviewed ranged from 10 to 30 kg, but it appeared that those individuals were not at all accustomed to estimating bait in kgs. One bucket observed seemed to be about 30 litres in size.
- Bagan and beach seine owners insist that a bucket of bait contains about 30 kg of bait and that a bucket contains about 25% water when transferring bait.
- A fleet owner indicated that his bait to tuna ratio is 1:7, and recognizes that it is small compared to pole-and-line fisheries in other countries. The fleet manager in the same company stated that his vessels take on 100 buckets and catch an average of 7 mt of tuna [but this seems improbable].
- ACIAR (2001) states that production of baitfish in the Bitung area attained 5,110 mt/yr, and the baitfish demand by 40 pole-and-liners based in Bitung only 3,720 mt/yr. A shortage of baitfish occurred in this area because the peaks of tuna and skipjack fishing seasons are not coincident with the peaks of baitfish numbers.
- Staff of DKP Bitung City states that in the high baitfishing season, there is enough bait for pole-and-line fleet.

The scope of the baitfishery(ies) in the area; the unit of coverage

- There are about a dozen discreet baiting areas in North Sulawesi Province. These are located on both the north and south sides of the peninsula and are in 6 districts of the province.
- In periods of low bait abundance, Bitung pole-and-line vessels sometimes pick up bait in the Bacan area.

The various baitfishing operations: types of operations, size of operations and techniques

- The bagans that provide bait are relatively small, typically 8m x 8m to 12m x 12m, but operate in association with 3 to 5 smaller light boats. The light boats usually have 6 to 8 100 watt above-water electric lights and 1 or 2 100 watt underwater lights. The light boats are stationed several hundred meters from the bagan and attract fish with lights. After sufficient bait has been attracted, the boats slowly approach the bagan and by light dimming, the attracted

fish are then attracted/ transferred to the bagan's lights for capture. The bagans usually have 4 to 6 petrol-powered lights but no underwater lights. The bagan net measures slightly smaller than the bagan (i.e. an 8m x 8m bagan would have a 7m x 7m net). The mesh size is 3 mm. Water depth is usually about 15 to 20 meters. Three crew are used on the bagan with an additional 2 crew on each associated light boat.

- Bait is also obtained by beach seine gear. Beach seines are typically 150 to 200m x 3.5m and have 3 mm mesh, except for larger mesh at the top. For pole-and-line vessels, beach seining appears to be an alternative technique when bait supplies from bagans are insufficient. A beach seine operation typically uses 10 to 15 crew and the setting/retrieval process takes about one hour. A beach seine set is usually done each day during the high season, but only about 3 times per week in the low season.
- It was explained by bagan and beach seine owners that during periods of low abundance, the bait is stockpiled for up to three days before a pole-and-line vessel is called in to pick up the bait.
- It was reported by a pole-and-line fleet owner that one vessel has tried boke ami gear, something learned by a captain who had experience on a Japanese pole-and-line vessel. Other vessel operators did not know of boke ami gear.
- There appears to be some sort of subsidy scheme for supplying gear (e.g. floats/lamps) to bagan operators.

The major baitfish species

- On the basis of interviews and examination of baitfish from a landing site, the main species of baitfish used by Bitung based boats are:
 - Two species of sardine are recognized, white ("putih abuabu") and red ("putih merah"). These two species appear to be *Encrasicolina heteroloba* and *E. devisi*, respectively. (but note SPC (2008) below)
 - The "lompa" appears to be the anchovy, *Thryssa baelama*.
 - The "lolosi" appears to be a fusilier.
 - The "tandipang" is identified as being *Sardinella fimbriata* by Itano (1993).
 - The "layang" is decapterus, with two species recognized: "*Malalugis abuabu*" and "*Malalugis angur*"
 - The "tambaga" appears to be a sardine.
 - The "Gosawo" is said to be similar to the white anchovy but longer. Itano (1993) gives "gosao" as a sprat (*Spratelloides* sp.) Bacan
- The white anchovy is thought to be the best bait, whereas the layang and tambaga are the hardest.
- ACIAR (2001) states from four kinds of fishing gear (lift net, beach seine, small/mini purse seine and scope net) more than 39 species of baitfish are caught.
- SPC (2008) identifies that the bait they took onboard their pole-and-line tagging vessel was *Encrasicolina punctifer*.

Cost of baitfish

- Bailey (2012) states that in the Bitung area the baitfish supply has been low in the past couple years, and the price of one bucket has gone up from about IDR 25,000 in 2006 to 150,000 in 2012.
- Price variation appears more to do with bait abundance than species composition. Layang, however, get a higher prices because of the large demand for this fish as food.
- Representatives of various companies and associations cite average bagan bait prices in North Sulawesi from IDR 50,000 to 200,000 per bucket, with anchovy receiving IDR 100,000 to 150,000 per bucket.
- Beach seine owners state that they do not sell bait by the bucket, but rather by the catch from a set. The price averages IDR 8 to 12 million for 80 to 150 buckets.
- Prices in neighboring Bacan are much lower, averaging about IDR 70,000. That low price is because only a few pole-and-line vessels are now based in Bacan.

Baitfish handling and wastage

- One fleet operator indicated that baitfish mortality on the pole-and-line vessels seemed to be about 30 to 40% over a three day period - but it would depend on the species, with layang mortality almost zero.
- Bagan owners state that baitfish mortality while the fish are in the bagan net averages 5% for anchovy and 0% for layang.
- Beach seine owners state that baitfish mortality before pick up by the pole-and-line vessel averages 5 to 10%.

- The baitfish transfer (bagan>pole-and-line vessel) as described by pole-and-line vessel operators and bagan owners consists of crowding the bait in the bagan net and using the transfer bucket as a scoop, without the use of a scoop net (i.e. fairly rough handling).
- Another operator indicated that, should the catch be primarily layang, they would be dry-scooped.
- If the transfer bucket contain close to 20 – 30 kgs of bait (as described above), it can be assumed that baitfish handling is quite rough.
- There is pumped circulation of water in the bait tanks when the pole-and-line vessel is not moving.

Who controls the baitfishing operations?

- There are several types of bagan ownership. The most common is having a single individual owner, but a few owners have more than one bagan. Some of the fishing companies own bagans; i.e. PT Bintang owns four. Sometimes a fishing company will loan money to a bagan fisher for bagan construction which creates a special arrangement between the company and fisher.
- In terms of operational fishing decisions, both bagan and beach seine owners state they have control of how/where the fish.
- There is a grouping of fishers (CPK) for each district that includes many types of small-scale fishers (bagans fishers comprise the largest membership share in Bitung). The primary purpose appears to be to distribute government grants for fishing gear. One bagan owner indicated that the allocation for about 10 bagans selected for assistance was about IDR 25 million.

Numbers of units; annual production

- The Annual Report DKP Bitung City 2011 states there are 45 mobile lift nets and 25 fixed lift nets in the area.
- The national fisheries statistics for 2011 show that in North Sulawesi Province in 2011 there were a total of 861 moveable bagans and that the catch of those vessels was 7,700 mt [as this is only 9 mt per bagan per year, it is likely to be erroneous]
- In interviews with fishing companies and fleet managers, the estimates of the number of bagans (not including associated light boats) in North Sulawesi ranged from 100 to 200. They also indicate that there are about 50 beach seines.
- In interviews with bagan owners, the number of bagans (not including associate light boats) in North Sulawesi was estimated to be about 100.
- In interviews with beach seine owners, the number of beach seines in North Sulawesi was estimated to be about 100.
- According to pole-and-line vessel operators, the poor fishing seasons for bagans are Dec-Feb and Jul-Aug when there are strong winds. Bagan operators, however, indicate that Jan-Mar is the low season and Jun-Aug is the high season.
- A fleet manager reported that in the good season, a single bagan can catch up to 200 buckets per night (i.e. one bagan supplying three pole-and-line vessels), while in the poor season it is closer to 20 buckets. Bagan owners, however, state that in the high season they average 50 buckets per night and in the low, 10 buckets. Beach seine owners cite 100 buckets per set in the high season and 10 buckets in the low.
- Fishing companies seem to keep good records of amounts of bait purchased (and money paid) by each pole-and-line vessel, but the species involved are not usually recorded.
- Representatives of various companies and associations indicate that most of the North Sulawesi bagan catch is for bait, with perhaps 20% used for food.
- Bagan owners say that the vast majority of their catch is used as bait, with only fish over 7 cm sold as food.
- Beach seine owners say that in the high season, 80% of their catch is used as bait, but in the low season 80% is used as food because of the prevalence of sardine in the catch, which pole-and-line fishers feel is an inferior bait.

The recent trends in the baitfishery, including trends in catches

- Although there is considerable uncertainty, the number of operational Bitung-based pole-and-line vessels has increased only slightly over the last 20 years.
- The number of bagans also appears to have increased over the last decade (catering to the baitfish needs of what they feel is an expanding pole-and-line fleet), while the number of beach seines has declined (low profitability).

- Fleet managers and vessel operators feel that bagan CPUE has fallen a bit in the last decade. This is mainly attributed to catches of the same fish by other gear types (e.g. shore-based fishing, small purse seining) and the effects of near-shore FADs (rumpons and garagara) on baitfish behavior, especially for layang. Bagan owners independently reiterated this contention.
- Bagan owners (who are very sensitive to wind/waves) indicate that the incidence of extreme weather has increased in the last decade.
- Bailey (2012) states that the baitfish supply has been low in the past couple years, and the price of one bucket has gone up from about IDR 25,000 in 2006 to 150,000 in 2011.
- Staff of DKP Bitung City say that in period of low bait catches, the bagans move more often, something that is occurring more in recent years.
- Some pole-and-line vessels tie up at the dock when bait supplies are insufficient. Those tie ups are increasing in duration in recent years (i.e. often for four days these days as opposed to one or two days in the past). When bagan catch rates fall, other pole-and-line vessels travel to Bacan to pick up bait.

What are the major concerns that management should address?

- Fishing companies and fleet managers indicate that there is conflict between bagan fishers for baitfishing area, rivalry between pole-and-line boats for the limited baitfish supplies at certain times of the year, and competition between gear types at the resource level. They also feel that something should be done about the effects of near-shore FADs on the behavior of layang.
- Bagan owners downplay any conflict between themselves and other types of fishers – but are quite fixated on improving the mechanisms for distributing government grants for bagan gear: selection process, bagans getting their fair share, and transparency.
- On the operational level, the fluctuating availability of baitfish is a major drag on the pole-and-line fleet.
- One fleet owner reported that kick-back payments by bagan operators to pole-and-line vessels distorts their understanding of baitfish shortages.
- Staff of DKP Bitung City state that bagans are not any more difficult to deal with than other gear types.

Current management of the baitfishery

- Pole-and-line owners and managers report that there is simply no management whatsoever of the fishery – not even a license is required for bagan fishing. This is apparently because the bagans “fish close to home”.
- Upon further questioning of the pole-and-line owners and managers, some interventions were uncovered: (a) an informal rule among bagan operators that a bagan should not encroach into another bagan’s fishing area, (b) bagans should fish close to shore so as not to disturb the navigation of other vessels, (c) no fishing/anchoring in the Bunaken National Park (heavy penalties), and (d) a common understanding not to fish near resorts.
- The bagan and beach seine owners say that they are definitely licensed: IDR 300,000 to the district for a bagan license and 150,000 for a beach seine. They agree that Bunaken is a no-take zone. They add that an informal rule among bagan operator stipulates that there should be at least 30 metres between bagans.
- Staff of DKP Bitung City agrees that the bagans and beach seines are licensed, and add (a) there are national regulations on fishing gear that are applicable to bagan fishing and (b) requirements (from the Ministry of Transport) that the bagans do not obstruct the movement of over vessels, and (c) there are two small MPAs established by communities (one in a coral area, one in a mangrove area, both 2 to 3 hectares in size) in which bagans cannot fish.
- None of the baitfishery stakeholders have heard of NGO involvement in marine resource management in the Bitung area.

The main institutional and procedural difficulties in the management of the baitfishery

- A fleet manager indicated that the DKP is sometimes useful, to the extent that they sometimes provide subsidized gear.
- DKP Bitung City was asked what would be the management response if a major drop in baitfishing CPUE should occur. They indicated that there would be a limitation of fishing gear or of fishing season. When asked how this would occur, they indicated “by the central government”. When asked about the district’s management authority inside four nautical miles, the response was unclear. When asked about examples of such a central government management response, the response was the two small MPAs established by communities (mentioned above) – which does not appear to be a central government response.

Aquaculture considerations

- Bailey (2012) stated there was lots of talk about aquaculture to help supplement supply, but the planned aquaculture is for milkfish, which the fishers said does not work as well as anchovy.
- A fleet owner stated that his company trialed cultured milkfish. The cost of the fingerlings (from Bali) were quite high and the cost per bucket was about IDR 500,000 bucket. His fishermen liked milkfish for pole-and-line bait.
- A fleet manager has heard of the culture of milkfish, but he is worried about the slow growth rate of milkfish.
- Staff DKP Bitung City are aware that some culture of milkfish for bait has taken place in the Bitung area – but this was for longline and handline bait, rather than pole-and-line bait.

MSC considerations

- A fleet/cannery owner stated that MSC is a trend among retailers, but it is hard for Indonesia to comply. Currently, up-front costs are too high for his company. He thinks the pole-and-line association will move forward with MSC – but it is a long-term goal. He said he was more interested in obtaining market security than a price premium for MSC fish - some of his buyers indicate that MSC certification will be required in about 5 years.
- Staff DKP Bitung City were unaware of MSC.

Main informants:

- DKP Bitung City, PT Samudra Mandiri Sentosa, PT Bintang Mandiri Bersaudara, National Fishing Boat Association (AKPN), bagan owners , beach seine owners

Appendix 5: Alternative Baitfish Capture and Handling Techniques

Robert Gillett April 2013

Acknowledgements

This short essay draws heavily on reports on baitfishing in the western Pacific by the South Pacific Commission, and on the writings of, and discussions with, Tony Lewis, David Itano, and Gert van Santen.

Alternative Baitfishing Techniques

A recent study (Gillett 2012) showed there are 16 countries in the world that have pole-and-line tuna fisheries which in recent years have produced more than 500 mt of tuna. 13 of those fisheries are located in temperate areas and/or have baitfisheries that are focused on one or two hardy baitfish species. Four pole-and-line fisheries have associated baitfisheries that involve tropical multi-species baitfisheries: Maldives, Lakshadweep, Indonesia, and the Solomon Islands. Because the Lakshadweep baitfishery is not well documented, the information in this report comes from the Solomon Islands (and some of the western Pacific baitfisheries that no longer exist), as well as some information from Indonesia.

In this section information on alternative baitfishing techniques is given in two categories: the gear and how the gear is used. Both sections draw on Hallier et al. (1982) and Dalzell and Lewis (1989).

The Gear

The best documented baitfishing operation from the western Pacific is that from the South Pacific Commission (SPC), which had a project operating two different pole-and-line vessels for a three year period in the late 1970s. In many respects the SPC's baitfishing gear and its operation reflected those of the pole-and-line fleets of many western Pacific countries. The main gear used was the Japanese stick-held dipnet, or "bouki-ami"¹. Box 2 gives specifications of the gear.

Box 2: Specifications of Gear Used for Baitfishing by the SPC

Underwater lights :

2000 watts - 200 volts
1500 watts - 110 volts
1000 watts - 110 volts

Above-water lights :

100 watts - 110 volts
300 watts - 200 volts
1000 watts - 200 volts

Portable generator :

Yanmar - 3000 watts - 100 volts

Bouki-ami : [nets from 2 different vessels]

1) 25 metres (float-line length); 27 metres (lead-line length); 23 metres (depth)
2) 27 metres (float-line length); 35 metres (lead-line length); 25 metres (depth)

Bamboo :

Length - 11 metres
Diameter - 12 cm

Skiffs (two per vessel) :

Length - 5.5 metres
Width - 1.5 metres

Buckets :

Volume : 13 and 15 litres
Material : Blue plastic

Bait-loading scoops :

Diameter 40 cm
Depth 27 cm
Handle length 80 cm
Mesh size 4 mm

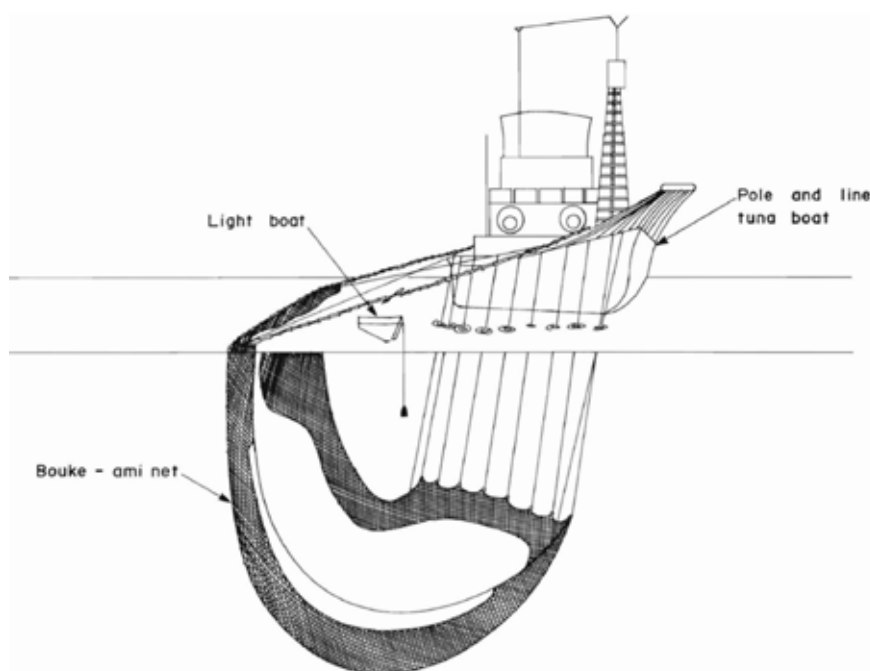


Figure 1: A Bouki Ami and the Associated Pole-and-Line Vessel

The shape of the net and its position relative to the pole-and-line vessel is shown in Figure 1 (from Dalzell and Lewis, 1989).

Most Japanese-style pole-and-line vessels operating in the central and western Pacific use underwater lights which are considered efficient in attracting most bait species. These lights are set between the surface and a normal maximum depth of 20 metres. Bait lights are normally powered by AC current of 100 to 220 volts, according to availability. Power can be supplied either directly from the vessel's main electrical system or from independent generators. During the transfer of bait from the bouki-ami net into the ship's bait tanks, one or more 40-watt above-water lamps are used to help control the behaviour of the bait within the net and to illuminate part of the deck.

A bouki-ami consists of a sheet of fine mesh netting mounted on a bamboo frame. The two nets used by SPC were (a) 25 metres long at the top, 27 metres at the bottom and 23 metres deep, and (b) 27 x 35 x 25 metres. Both nets were made from 4 mm square mesh knotless netting made of brown polyamide nylon. The bottom edge of the net is weighted with 20 sinkers, of 3.5 kg each, placed 2 metres apart with two at each corner. A 20-kg lead-line is attached to the net a third of the distance from the top edge. This helps to keep the net vertical before hauling and prevents folds from forming in the bag while the net is being closed. Eighteen 30-metre lines attached from the sponson to the bottom lead-line allow the net to be hauled. Two lines, attached on the fore and aft net sides, 2 metres from the bottom of the net, are hauled by power winches and ensure faster closure of the net.

The Use of the Gear

The principles of night baiting are the same for bouki-ami, lampara, purse-seine nets, or other gear. Powerful lights are employed either above or under-water to attract fish. When sufficient fish have gathered close to the lights, net is set to catch them. The net, when pulled, forms an enclosure or bag in which the fish are trapped. Different types of nets suit different fishing conditions and purposes, the end results being that baitfish are caught and loaded live into bait tanks.

In a typical bouki ami operation before nightfall a 1500-watt light would be immersed 10 metres under the skiff, the generator started, and the skiff allowed to drift away from the stern of the pole-and-line vessels on its 100-metre-long topline. At the same time, on

the port-side near the bow, a 2000-watt light is immersed to a depth of 15 metres. This light is suspended from a bamboo pole which extended about 5 metres from the port side of the pole-and-line vessel. An underwater light of between 1000 and 2000 watts is occasionally set 7 to 10 metres underwater at the stern. Rheostats enabled the light intensity to be varied as required.

After the lights are operating for four or five hours, a check for the presence of bait is made. The skiff light and the underwater bow light are moved along the port-side to midship. As the skiff is slowly drawn to the stern of the ship, and subsequently to midship, the stern light is gradually dimmed to zero, merging the two schools of bait. Simultaneously, the bow light is brought up from a depth of 15 metres to a depth of about 7 metres, and moved from bow to port midship. The quantity of baitfish present is then checked with an underwater viewing glass from the skiff, and with an echo-sounder. If, on inspection, the quantity of bait is considered to be insufficient, then all lights are switched on again and moved back to their original positions. When sufficient bait had gathered, bait catching operations started.

Available crew then take up positions on the starboard sponson and at the ends of the three cross-poles. The bamboo float is then lowered from the sponson into the water and

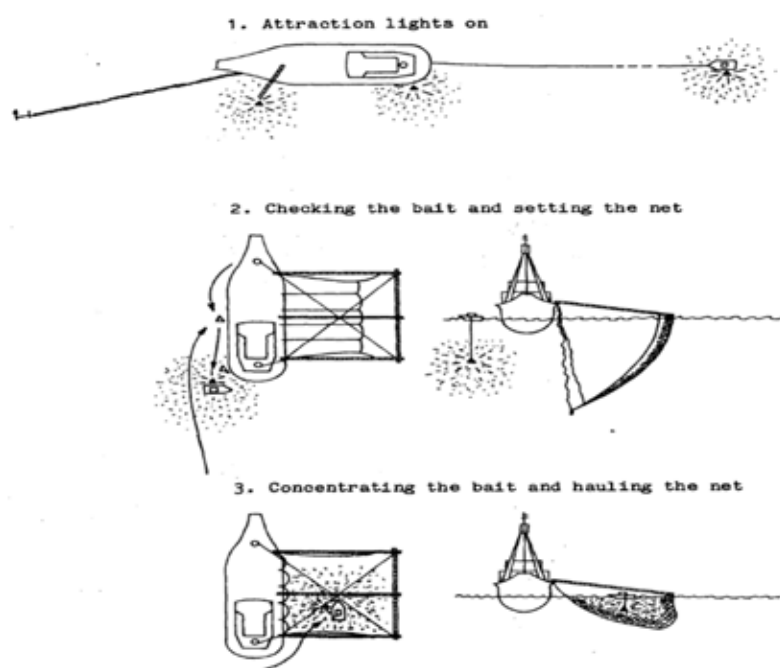


Figure 2: The Stages of the Bouki Ami Operation (from Hallier et al. 1982)

gently pushed by the cross-poles away from the vessel. The net, which is lying along the starboard sponson, is then gradually spread out. When the bamboo float is about 18 metres from the side of the ship, the ends of the cross-poles are securely fastened to the vessel's gunwhale and two spring lines are tied diagonally across the net to strengthen the framework. The bottom of the net, along with the sinkers and connecting lines are then thrown overboard from their position on the sponson. While the net is sinking, the fishermen check the tension on the lines to make sure that the net is spreading out evenly. The Captain also checks the position of the net from the upper deck. The area bound by the bamboo, the net and the vessel forms a box, approximately 26 metres long by 18 metres wide. The attracted bait must then be drawn to a catching position between the net and the vessel before the net is raised from its vertical position under the bamboo float.

Two men direct the skiff and its light around which the bait gathers, towards the starboard side of the ship. The skiff passes under the stern cross-pole and is moved forward to the middle of the rectangle formed by the bamboo frame and the ship. All movements of the skiff and the attached light must be very slow so that the baitfish follow the light and do not panic. When the skiff reaches the middle cross-pole, the light intensity is reduced. The degree of dimming depends upon the brightness of the moon, the water clarity and the species of bait present. In addition, the light is brought up slowly from a depth of 10 metres to within 1 metre of the surface. The purpose of these two simultaneous operations is to aggregate the baitfish and bring them close to the surface where they are more vulnerable to the net. Baitfish behaviour is monitored with an underwater viewing glass and an echo-sounder. If the bait does not gather satisfactorily around the light, further adjustments of the light are made. If all is well, the net is hauled.

When the Captain determines that sufficient bait has concentrated around the light between the vessel and the bamboo float, a signal is given for the crew to begin pulling the ropes. The two side ropes, which are under considerable tension, are hauled by power winches located at the bow and at the stern of the ship. These close the fore and aft sides of the net while the ropes attached to the bottom of the net are pulled more slowly by hand. With all net edges at the surface, the enclosure, or bag, thus formed traps the bait. As soon as this bag is properly closed, the underwater light in the net is switched off and removed from the water. The skiff is then moved out of the net by the same route as it was entered.

The size of the bag is gradually reduced by hauling the net on board and pulling in the bamboo cross-poles. This work is carried out with the help of the two men in the skiff (see Figure 3). During these operations, aimed at concentrating the baitfish, the lead-line incorporated into the mid-section of the net helps to keep folds from forming in the net, thereby preventing live bait from being trapped in small pockets.

The final crowding of the bait in the net takes place at the middle of the starboard side of the pole-and-line vessel where the sponson is lowest. A plank is then placed across the net, one end resting on the skiff and the other suspended from a strong rope attached to the gunwhale. Two men are positioned on the plank; one guiding bait into buckets and the other lifting the full buckets and handing them to fishermen standing on the ship's sponson who then pass them from hand to hand and empty them gently into the bait tanks.

Recent Innovations

The above information draws heavily on Dalzell and Lewis (1989) and especially Hallier et al. (1982). Bouki ami operations, like most fishing techniques, evolve over time. According to discussions with a person familiar with current baitfishing in the Solomon Islands (A.Lewis, per.com., February 2013) recent innovations are:

- The use of stronger lights – the underwater lights are now mostly 2,000 watt quartz iodide
- The use of more lights – some vessels use three underwater lights suspended from the pole-and-line vessel.



Figure 3: The Final Stages of Hauling the Bouki Ami



Photo: R. Jauhari



Photo: C. Anderson

Figure 4: dry scooping baitfish into bait tanks (left) and flinging the baitfish into bait tanks (right)

- The use of larger nets – a bouki ami of 30 x 35 metres is typical
- More net hauls per night but smaller catches – which results in less trauma to the baitfish

Baitfish Handling

As mentioned above, night-time baiting catches mainly the silver sprat, anchovy, and blue sprat. These three species are more fragile than the fusiliers and cardinalfish that are very common in the traditional day-time catches. Specialized handling techniques are required for fragile species to attain good survival in the bait tanks of pole-and-line vessels. A possible reason for the lack of development of appropriate handling techniques is that overseas fishing specialists advising on baitfishing capture in the Maldives appear to have come mainly from Japan and Hawaii, locations that have very hardy baitfish species.

In general, sprats and anchovies that suffer trauma, have physical abrasion with the net, crash into the bait tank walls/fixtures, are dumped into a bait tank, and/or suffer loss of scales tend to have much higher mortality than baitfish that does not undergo such stress.

Dry-scooping these baitfish and/or flinging them from the net into the bait tanks appears to be common practice in Maldivian baitfishing. While this may be appropriate for very hardy species (e.g. fusiliers), it results in high mortality and therefore waste when handling Maldivian sprats and anchovies.

In discussions with MRC staff and with fishermen it appears that the most important improvement to assure higher survival in the bait tanks consists of how the baitfish are crowded/removed from the net. Also important are (a) how the baitfish are placed in the bait tanks and (b) some physical aspects of the bait tanks.

Rather than dry-scooping or flinging the bait into the bait tanks, it is strongly suggested that the baitfish in the net are gently guided by a flat scoop into 15 litre blue plastic buckets. Figure 5 shows the man in the blue shirt encouraging about 1.5 kg of bait to swim into a blue bucket. The overhead light has some calming effect on the baitfish.

It should be noted that getting about 1.5 kg of bait into each bucket (a skill that can be learned with practice) could mitigate a problem in the management of the Maldives baitfishery: estimation of the amount of bait captured in a haul – as all that needs to be done is to count the number of 1.5 kg buckets that are loaded.

The buckets with baitfish are gently passed by several crew members to the bait tank. Here the buckets are carefully submerged in the tank and the fish are tenderly encouraged to swim out of the buckets (Figure 6).

Compared to the smooth bait tanks Japanese-style pole-and-line vessels in the western Pacific, the bait tanks on some Maldivian vessels appear very cluttered, with lots of



Figure 5: Gently Loading Bait into Plastic Buckets



Figure 6: Passing the Buckets to the Bait Tanks

obstructions like hull ribs, piping, valves, and partitions. This has implications for the orderly swimming of baitfish, as well as the ease of removing baitfish from the tank during tuna fishing. The bait tank of a Maldivian vessel (Figure 7) can be compared to that of a western Pacific pole-and-line vessel (Figure 8).

Concluding Remarks

The “low-hanging fruit” of baitfishing improvements in the Maldives appears to be a gentler handling of the fragile species of baitfish (i.e. sprats and anchovies) that are often captured during night-time fishing. Modifications to bait wells are likely to result in higher survival of baitfish, although retro-fitting on older vessels may be quite expensive.

The use of underwater lights in conjunction with dimming switches should be trialed. Attempts are now being made to locate a supplier of this gear. One fleet of pole-and-line vessels in the western Pacific manufactured their own underwater lights.



Figure 7: The Bait Tank of the Maldivian Vessel Kobin



Figure 8: The Orderly Swimming of Baitfish in a Bait Tank of a Pole-and-Line Vessel of the Western Pacific

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Appendix 6: Some Notes on the Baitfish Component of MSC Certification of Pole-and-Line in Other Countries

To add some context to the discussion of the MSC requirements for the baitfishing component of a pole-and-line fishery, the assessment reports of three pole-and-line fisheries to have been certified were studied.

Tosakatsuo Skipjack Pole & Line Fishery

The words “bait” or “baitfish” only appears in the assessment report a few times. The only significant mentions (i.e. use of word aside from use in the describing the fishery) are:

- “The only bait purchase are monitored by the fishermen’s association at the landing site in Japan”
- “Anchovy bait, the harvest of which is carefully monitored and managed by a TAC, is purchased from dealers around Japan.” [strictly speaking, the statement is not true: the bait is not subject to a TAC, but all anchovy catches]

Mexico Baja California Pole & Line Yellowfin & Skipjack Tuna Fishery

The words “bait” or “baitfish” appears in the assessment report 43 times. Significant mentions include:

- The estimated annual harvest of sardine by four P&L boats would be about 80 mt. This represents a small proportion (0.2%) of the commercial harvest expected by Nevarez et al, 2006, assuming a catch for a stable stock of 40,000 mt. If the same usage was to apply to an extended fleet of 12 vessels, 0.6% of the expected commercial harvest would be needed for bait. This confirms the minimal actual and potential impact of the P&L operation on the stock of sardine from Bahia Magdalena. The sardine fishery is regulated by Mexican Standard NOM-PESC-003-1993 which establishes a minimum catch size (150mm FL) for the Monterrey sardine and restricts the number of permits.
- While the impact of the bait fishery has not been specifically studied due to it accounting for a small proportion of the annual catch, the commercial sardine

fishery in the region has been researched (Nevares et al, 1996, Morales-Bojórquez et al, 2003, Moral-Simanek et al, 2010).

- The relatively low catch of YFT and SKJ as well as retained or discarded non-target species including bait by the P&L fishery is unlikely to have a significant impact on the ecosystem including food webs, structure and ecosystem function.
- By the first annual audit, the companies owning certified vessels must have designed and implemented a system to provide reliable information on the amount of Monterrey sardine harvested to be used as bait. By the second annual audit, there will be documented evidence that the information is being collected on a continuous basis and data is available by vessel.

Pole-and-line Skipjack Fishery in the Maldives

The words “bait” or “baitfish” appears in the assessment report 382 times. Significant mentions include:

- The main concern in terms of retained species is the catch of the bait that takes place in lagoons prior to the start of fishing trips. While there are estimated to be up to 40 individual species used as bait, there are a limited number of main species. There are variations in the relative importance of the different species between years, seasons and area. Silver sprat is the most important species. The bait species are fast growing, fast reproducing fishes with high rates of natural mortality. In such cases, classic fisheries assessment advice has been that catches can be high relative to biomass with little fear of overexploiting the resource. This appears to have been the case for the Maldives fishery, although the previous rise in live bait catches in the 20 year period until 2006 was a cause for concern about over fishing, particularly at a local level. With the decline in the SKJ fishery, the use of bait has reduced considerably from its peak and the total annual catch is estimated to be about 8,000 mt. Work is progressing on developing a management plan for live bait and it is anticipated that following a series of activities one will be available by 2014.
- With the decline in the SKJ fishery, the use of bait has reduced considerably from its peak so that the total catch is estimated to be about 8,000 mt. Using the data in

table 3, it would appear that silver sprat and blue sprat may be considered as main retained species (i.e. > 5 % of the total catch). There are no signs that bait use is exceeding the MSY for these species at present, although there is a risk that this might occur if fishing effort for these species were to increase again.

- MRC continues to conduct baitfish monitoring, as it has done for many years. It had a particularly extensive programme during 2000-04. It has now embarked on a regional catch sampling programme (Anderson, 2009 a, b, c) as part of a wider national bait fishery monitoring programme. The main aims of this programme are to quantify catches and to highlight any problems with fishery and the bait fishery resources. At the same time, the MoFA has reiterated its commitment to sustainable utilization of marine resources, and its determination to enact appropriate management strategies as required. This, and the continuing decrease in fishing effort, contributes to the high degree of confidence that management of baitfish resources will be successful in the near future.
- Condition 4: By the fourth annual audit a partial strategy for the management of bait fish must have been implemented that reduces the risk of Maldives wide and local depletion, there is evidence that the partial strategy has been implemented and there is some objective basis for confidence that the partial strategy will work.
- Condition 5: By the first annual audit, there will be documented evidence that the Government of Maldives is collecting the information needed to support a partial strategy to manage bait fisheries.
- “Completion of the Action Plan for Condition 4 will also meet the requirements of Condition 5”.

Appendix 7: Factors Affecting the Success of a Tuna Management Plan

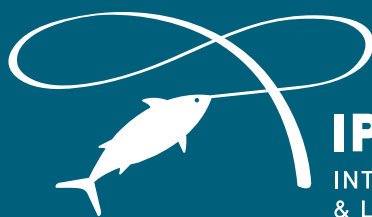
The study of tuna management plans (TMPs) is especially instructive for baitfish management plans in Indonesia. Accordingly, the success factors are analyzed in summary form in the table below.

A more thorough discussion is available in Gillett, R. (2009). Tuna Management Plans in the Pacific Ocean - Lessons Learned in Plan Formulation and Implementation. Forum Fisheries Agency, Honiara, 45 pages.

Factor	Comment
The major factors that affect the success of a tuna management plan	<p>Experience over the past decade suggests the following are the most important:</p> <ul style="list-style-type: none"> • Length/complexity of the plan document • Presence of mechanisms to assure adherence to the plan • How management and development are mixed in a single plan • The type of external assistance used in plan formulation
Length/complexity of the plan document	<ul style="list-style-type: none"> • A short/simple/understandable document is more likely to be successful than a more complete/complex document in a developing country. • The idea of having much of the information related to tuna management in one document has advantages, but if documents together are considered “the plan” – which is usually the case despite attempts by the authors to distinguish it from supporting documents - this frightens important stakeholders. • Short plans tend to force a degree of simplicity and clarity.
Mechanisms to assure adherence to a plan	<ul style="list-style-type: none"> • Even with a good TMP and an effective fishery management agency, mechanisms to encourage adherence to processes prescribed in the plan may be required for the proper functioning of the plan. • In countries where there are legitimate reasons for a TMP not to have the force of law, alternative mechanisms to encourage adherence to the plan become especially important. • These alternative mechanisms could include (a) formal procedures for dealing with grievances, (b) a dedicated individual within the government fisheries agency who has primary responsibility for TMP implementation, (c) enhanced requirements for stakeholder consultation, and (d) assistance from a dedicated external individual.

Continued on pg 132

Factor	Comment
How management and development are mixed in a single plan	<ul style="list-style-type: none"> • If a TMP is to include a substantial development component, any specific development initiatives and associated recommendations should be partitioned off. Otherwise, if they are inter-twined, this often has negative impacts on implementing the broader plan - even the inherently simple components. • The “do-able” management component often gets sunk by the aspirational (and often expensive) development component.
The type of external assistance used in plan formulation	<ul style="list-style-type: none"> • The ideal supplier of external assistance in plan formulation would be a participant in a process (rather than the driver), have enough time and patience to proceed at the speed of co-participants (rather than trying to push the system faster than its normal rate), have broad experience in tuna fishery management, and not see his role as “selling” to the country pre-determined concepts or plan features. • Those countries that are assertive with external assistance providers as to what is needed, appropriate and practical, seem to end up more satisfied with their TMPs.



IPNLF

INTERNATIONAL POLE
& LINE FOUNDATION

UK Office

Registered Address: 1 London Street, Reading,
United Kindom RG1 4QW

Registered Charity: 1145586 (England and Wales)

Maldives office

IPNLF c/o 1st Floor, M. Mist, Fiyaathosi Magu, Malé-20223,
The Republic of Maldives

Web: www.ipnlf.org

Email: info@ipnlf.org

Twitter: www.twitter.com/IPNLF

Cover image: A bait boat (or bagan) in Indonesia

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